SOIL SURVEY OF

Morris County, Kansas

United States Department of Agriculture
Soil Conservation Service
In cooperation with
Kansas Agricultural Experiment Station

Issued November 1974

Major fieldwork for this soil survey was done in the period 1958–68. Soil names and descriptions were approved in 1969. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1969. This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station. It is part of the technical assistance furnished to the Morris County Soil Conservation District.

Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on individual order from the Cartographic Division, Soil Conservation Service, United States Department of Agriculture, Washington, D.C. 20250.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in determining the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All the soils of Morris County are shown on the detailed map at the back of this survey. This map consists of many sheets that are made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbol. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information in this publication. This guide lists all the soils of the county in alphabetic order by map symbol. It also shows the page where each soil is described and the page for the range site, the woodland suitability group, and the windbreak suitability group in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the capability units and other management groups.

Foresters and others can refer to the section "Use of the Soils for Woodland and Windbreaks," where the soils of the county are grouped according to their suitability for trees.

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Use of the Soils for Wildlife."

Ranchers and others can find under "Range Management" groupings of the soils according to their suitability for range and the names of many of the plants that grow on each range site.

Community planners and others can read about soil properties that affect the choice of sites for recreation areas in the section "Soil Interpretations for Recreational Uses."

Engineers and builders can find under "Engineering Uses of the Soils" tables that give engineering descriptions of the soils in the county and that name soil features that affect engineering practices and structures.

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of the Soils."

Newcomers in Morris County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "Additional Facts About the County," which gives additional information about this area.

Cover: **Area of range consisting of Irwin soils. The cattle obtain water from the pond in the background.**

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SOIL SURVEY OF MORRIS COUNTY, KANSAS

BY WESLEY L. BARKER, SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE KANSAS AGRICULTURAL EXPERIMENT STATION

MORRIS COUNTY is located in the east-central part of Kansas (fig. 1). It has a total area of 452,480 acres. Council Grove, the county seat, is in the east-central part of the county.

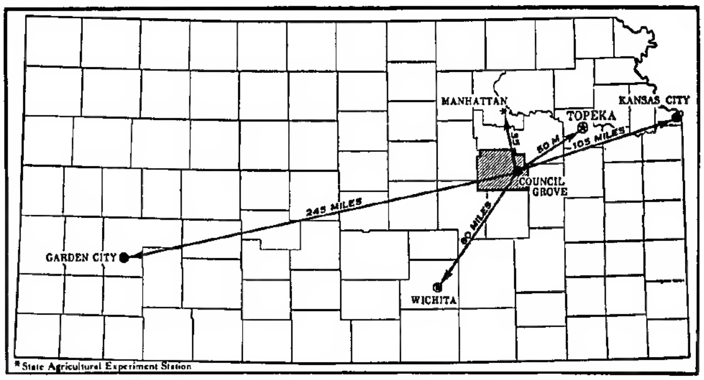

Figure 1.—Location of Morris County in Kansas.

Farming and ranching are the main enterprises. About 57 percent of the total acreage in the county is in native range. The cultivated areas are largely used to grow feed for livestock, but wheat, soybeans, and other cash-grain crops are grown to some extent.

Beef cattle are the main kind of livestock, but swine and dairy cattle are also raised. Most of the large ranches are in the southern and eastern parts of the county; a few are in the northwestern part.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Morris County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes, the size and speed of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The soil series and the soil phase (*10*) [1] are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Dwight and Reading, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Irwin silty clay loam, 0 to 1 percent slopes, is one of several phases within the Irwin series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Two such kinds of mapping units are shown on the soil map of Morris County: soil complexes and undifferentiated groups.

A soil complex consists of areas of two or more soils, so intermingled or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant

[1] Italic numbers in parentheses refer to Literature Cited, p. 52.

soils, and the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen. An example is Labette-Dwight complex, 1 to 3 percent slopes.

An undifferentiated group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils, or of two or more. The name of an undifferentiated group consists of the names of the dominant soils, joined by "and." Ivan and Kennebec silt loams is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, or so severely eroded that it cannot be classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Alluvial land is a land type in Morris County.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soil in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in such a way as to be readily useful to different groups of users, among them farmers, managers of woodland and rangeland, and engineers.

On the basis of yield and practice tables and other data, the soil scientists set up trial groups. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others; then they adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Morris County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The five soil associations in Morris County are discussed in the following pages. Names of some of the soils mentioned in these soil associations are unlike those that appear in recently published surveys for adjacent counties. Differences are the result of refinements in the concepts of soil series in the application of the soil classification system.

More detailed information about the individual soils in each association can be obtained by studying the detailed soil map and by reading about the soils in the section "Descriptions of the Soils."

1. Labette-Florence association

Moderately deep, gently sloping to sloping soils that have a clayey subsoil, and deep, sloping to moderately steep cherty soils that have a cherty clay subsoil; on uplands

This association, locally called the Flint Hills, is deeply dissected by drainageways. It consists of soils that formed over cherty limestone, limestone, and shale (fig. 2). The soils in about 85 percent of the acreage are sloping or moderately steep, and in about 15 percent they are gently sloping. In a few small areas on ridgetops and along some drainageways, the soils are nearly level (fig. 3). This association occupies about 39 percent of the county.

Well-drained Labette soils make up about 26 percent of the association. They generally occur at a higher elevation than Florence soils. Labette soils have a surface layer of dark grayish-brown silty clay loam about 8 inches thick and a subsoil about 18 inches thick. The upper 6 inches of the subsoil is brown, firm heavy silty clay loam, and the lower 12 inches is reddish-brown, firm silty clay. Below the subsoil is cherty limestone.

Florence soils, which also are well drained, make up about 21 percent of the association. They are on narrow ridges, or they occupy the upper parts of side slopes at a lower elevation than the Labette soils. Florence soils have a dark grayish-brown surface layer about 11 inches thick. This layer is cherty silt loam in the upper 4 inches and cherty silty clay loam in the lower 7 inches. The subsoil, which is about 33 inches thick, is brown, firm cherty heavy silty clay loam in the upper 4 inches and dark reddish-brown, very firm coarse cherty clay in the lower 29 inches. Below the subsoil is cherty limestone bedrock that contains a few cracks filled with red clay.

Tully soils are on colluvial side slopes below Florence soils, and they make up about 16 percent of the association. Gently sloping Dwight soils that have a thin surface layer and that occupy areas above and with the Labette soils make up about 15 percent. The rest of the association consists of Irwin, Clime, Sogn, and Reading soils and areas of Alluvial land. In places the gently sloping and sloping Irwin soils are in areas below the Tully soils. The Clime and Sogn soils are on side slopes in lower positions than the Florence soils. Alluvial land and the Reading soils are along some drainageways.

The raising of beef cattle is the major enterprise in this association. About 90 percent of the acreage is used as native range, and the rest is used mainly to grow feed

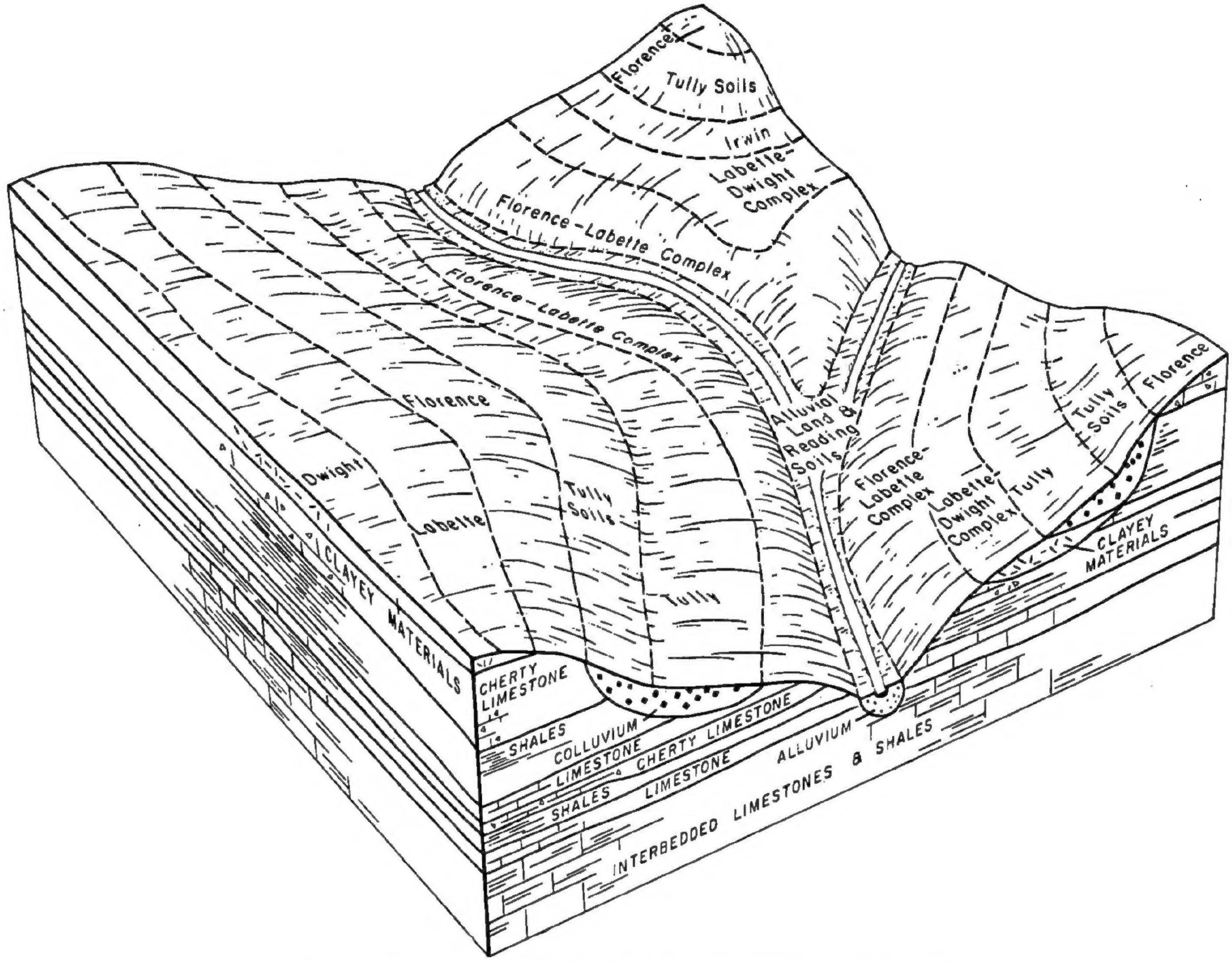

Figure 2.—Typical pattern of soils and underlying material in association 1.

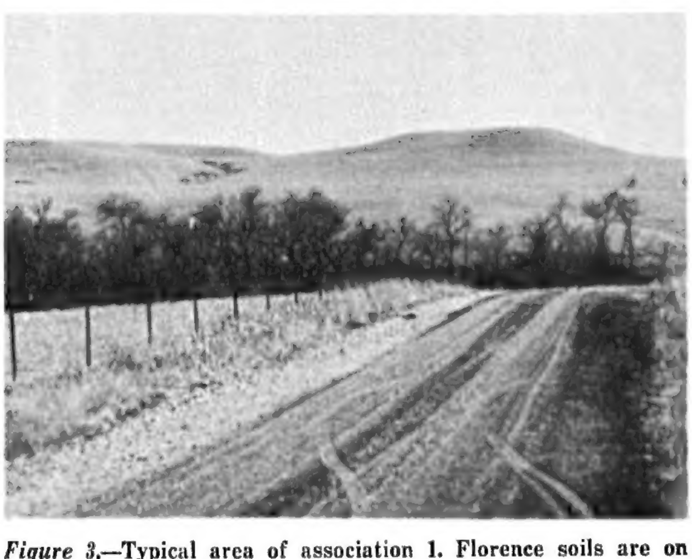

Figure 3.—Typical area of association 1. Florence soils are on ridges in the background; Tully soils, 5 to 15 percent slopes, are on side slopes immediately below the Florence soils; and other Florence soils that are mapped in a soil complex with Labette soils occupy the area adjacent to the tree-lined drainageway.

for livestock. The soils are well suited to grass. Good grazing management is needed to keep the range in good condition.

2. *Irwin-Ladysmith association*

Deep, nearly level to sloping soils that have a clayey subsoil; on uplands

This association consists of soils on broad upland divides that are dissected in places by intermittent streams. These soils formed in fine-textured sediment weathered from shale, in old alluvium, or in windblown material (fig. 4). This association occupies about 33 percent of the county.

Moderately well drained and well drained Irwin soils make up about 51 percent of this association. These soils have a surface layer of dark grayish-brown silty clay loam about 10 inches thick. The subsoil is very firm, brown silty clay about 50 inches thick. The Irwin soils are mostly gently sloping and sloping and occur on side slopes, but a few areas are nearly level.

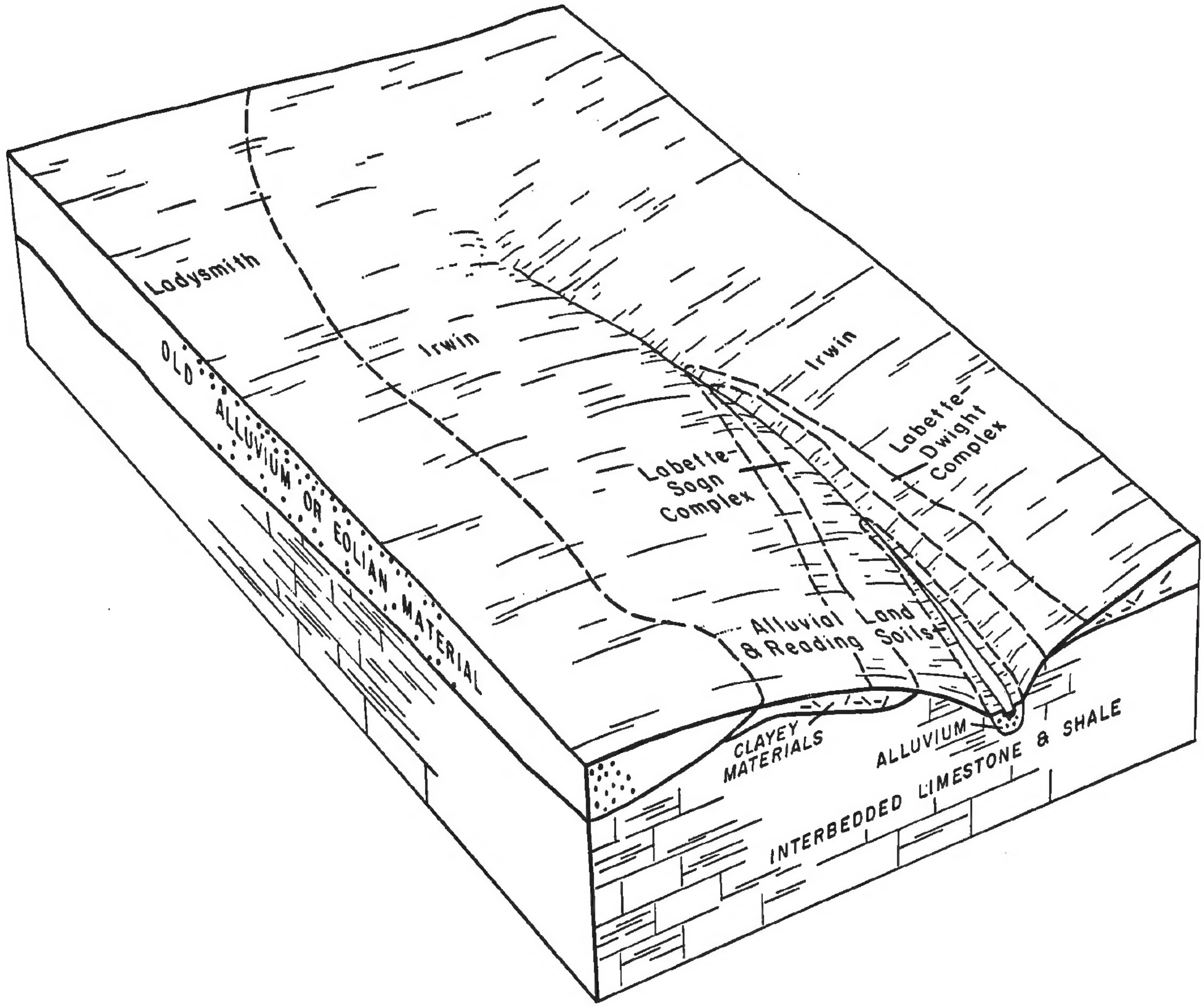

***Figure 4.*—Typical pattern of soils and underlying material in association 2.**

Moderately well drained or somewhat poorly drained Ladysmith soils make up about 26 percent of the association. They have a surface layer of dark-gray silty clay loam about 8 inches thick. The subsoil is about 42 inches thick. It is very firm, dark-gray silty clay in the upper 26 inches and very firm, light brownish-gray light silty clay in the lower 16 inches. The substratum is light brownish-gray silty clay loam. Ladysmith soils are mainly on ridgetops and are nearly level and gently sloping.

Alluvial land and Reading, Labette, Dwight, and Sogn soils make up 23 percent of this association. Alluvial land and Reading soils occur along the larger natural drainageways. The Sogn soils are in intricate patterns with Labette soils near the natural drainageways. Most areas of the Dwight soils occur closely with Labette soils immediately above areas of Labette and Sogn soils.

About 70 percent of the acreage in this association is cultivated and is suited to most crops commonly grown in the county, except corn. The remaining 30 percent is used for pasture and range. The soils are eroded in many of the cultivated areas. Controlling erosion and maintaining soil tilth and fertility are the main concerns in managing the cultivated areas (fig. 5).

3. *Chase-Mason-Reading association*

Deep, nearly level soils that have a clayey and loamy subsoil; on stream terraces

This association consists of nearly level soils that formed in alluvium (fig. 6). These soils are on valley floors and are subject to occasional flooding. This association occupies about 1 percent of the county.

Moderately well drained Chase soils make up about 40 percent of the association. These soils have a surface layer of silty clay loam about 14 inches thick. The upper 7 inches of this layer is grayish brown, and the lower 7 inches is dark gray. The subsoil is about 30 inches thick. The upper 6 inches is firm, dark-gray heavy silty clay loam. The next 24 inches is very firm silty clay that

Figure 5.—Terraces that help to control erosion in a field occupied by Irwin soils of association 2. These soils are farmed on the contour.

is dark gray in the upper 12 inches and gray in the lower 12 inches. The substratum is light brownish-gray heavy silty clay loam. The Chase soils are farther from the stream than the Mason and Reading soils.

Well-drained Mason soils make up about 27 percent of this association. These soils have a surface layer of silt loam about 14 inches thick. The upper 7 inches of this layer is grayish brown, and the lower 7 inches is dark grayish brown. The subsoil is about 41 inches thick. It is friable, dark-brown light silty clay loam in the upper 7 inches; firm, brown silty clay loam in the middle 18 inches; and friable, brown silty clay loam in the lower 16 inches. The substratum is light yellowish-brown light silty clay loam. The Mason soils are closer to the stream than the Reading and Chase soils.

Well-drained Reading soils make up about 17 percent of this association. They have a surface layer of dark grayish-brown silt loam about 15 inches thick. The subsoil is about 39 inches thick. It is firm, brown silty clay loam in the upper 9 inches; firm, brown heavy silty clay loam in the middle 18 inches; and firm, pale-brown heavy silty clay loam in the lower 12 inches. The substratum is pale-brown light silty clay. Reading soils are farther from the stream than Mason soils and closer to the stream than Chase soils.

The Ivan and Kennebec soils make up about 10 percent of the association and are on the frequently flooded first bottoms. Osage soils make up about 6 percent of the association and are in nearly level areas and in depressions where sediment has been deposited by backwater.

Most of the acreage in this association is cultivated and is suited to all crops commonly grown in the county. Osage soils, however, are not well suited to corn, and Ivan and Kennebec soils are not well suited to wheat. Proper use of crop residue is the main concern in managing these soils.

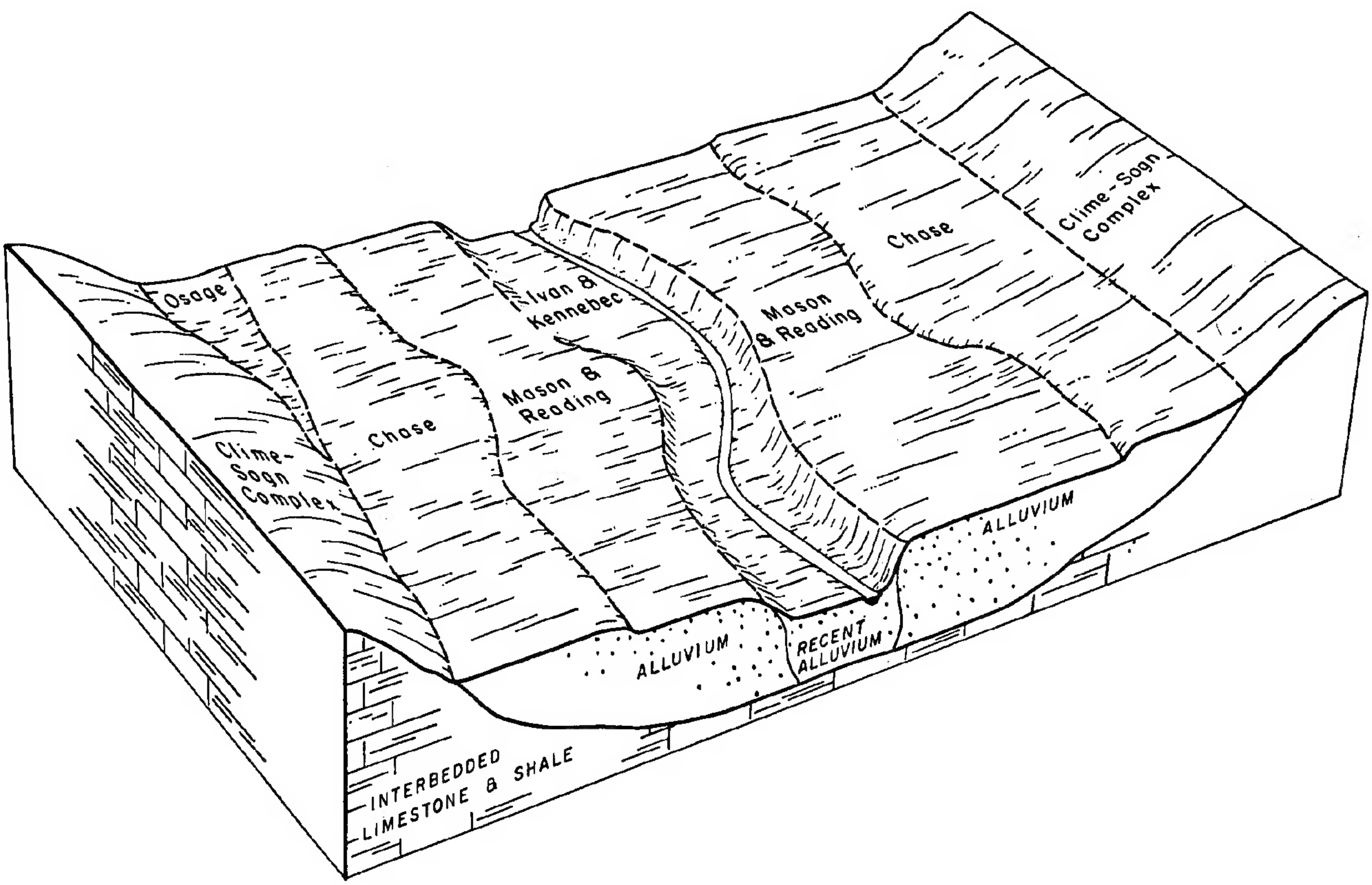

Figure 6.—Typical pattern of soils and underlying material in association 3. In many places Clime and Sogn soils, closely intermingled and mapped together, border soils of this association.

4. *Mason-Tully-Reading association*

Deep, nearly level to sloping soils that have a loamy and clayey subsoil; on stream terraces and uplands

This association consists of soils that formed in alluvium or material washed from nearby slopes (fig. 7). About 65 percent of the association is nearly level soils on valley floors that are occasionally flooded; the rest is gently sloping and sloping soils along the valley sides (fig. 8). This association makes up about 13 percent of the county.

Well-drained Mason soils make up about 30 percent of this association. They have a surface layer of silt loam about 14 inches thick. The upper 7 inches of this layer is grayish brown, and the lower 7 inches is dark grayish brown. The subsoil is about 41 inches thick. It is friable, dark-brown light silty clay loam in the upper 7 inches; firm, brown silty clay loam in the middle 18 inches; and friable, brown light silty clay loam in the lower 16 inches. The substratum is light yellowish-brown light silty clay loam. Nearly level Mason soils are on stream terraces and are closer to the stream than Reading soils.

Tully soils, which also are well drained, make up about 28 percent of the association. They have a surface layer of dark-gray silty clay loam about 11 inches thick. The subsoil is about 41 inches thick. The upper 6 inches of the subsoil is firm, grayish-brown heavy silty clay loam; the next 13 inches is firm, dark-brown silty clay; the next 14 inches is firm, brown silty clay; and the lower 8 inches is firm, yellowish-brown silty clay. Tully soils occur in colluvium on uplands.

Well-drained Reading soils make up about 20 percent of the association. They have a surface layer of dark grayish-brown silt loam about 15 inches thick. The subsoil is about 39 inches thick. It is firm, brown silty clay loam in the upper 9 inches; firm, brown heavy silty clay loam in the middle 18 inches; and firm, pale-brown heavy silty clay loam in the lower 12 inches. The substratum is pale-brown light silty clay. Reading soils are nearly level and gently sloping and occur on stream terraces farther from the stream than Mason soils.

Ivan and Kennebec soils make up about 13 percent of the association and are on the frequently flooded first bottoms. Chase, Ladysmith, and Smolan soils make up 9 percent of the association. Chase soils are along the lower reaches of major streams, farther from the stream than the nearly level Mason and Reading soils. Ladysmith and Smolan soils are on uplands and old, high stream terraces in about the same position as Tully soils.

Most areas of the soils in this association are cultivated and are suited to most crops commonly grown in the county, except that corn is not well suited to the soils

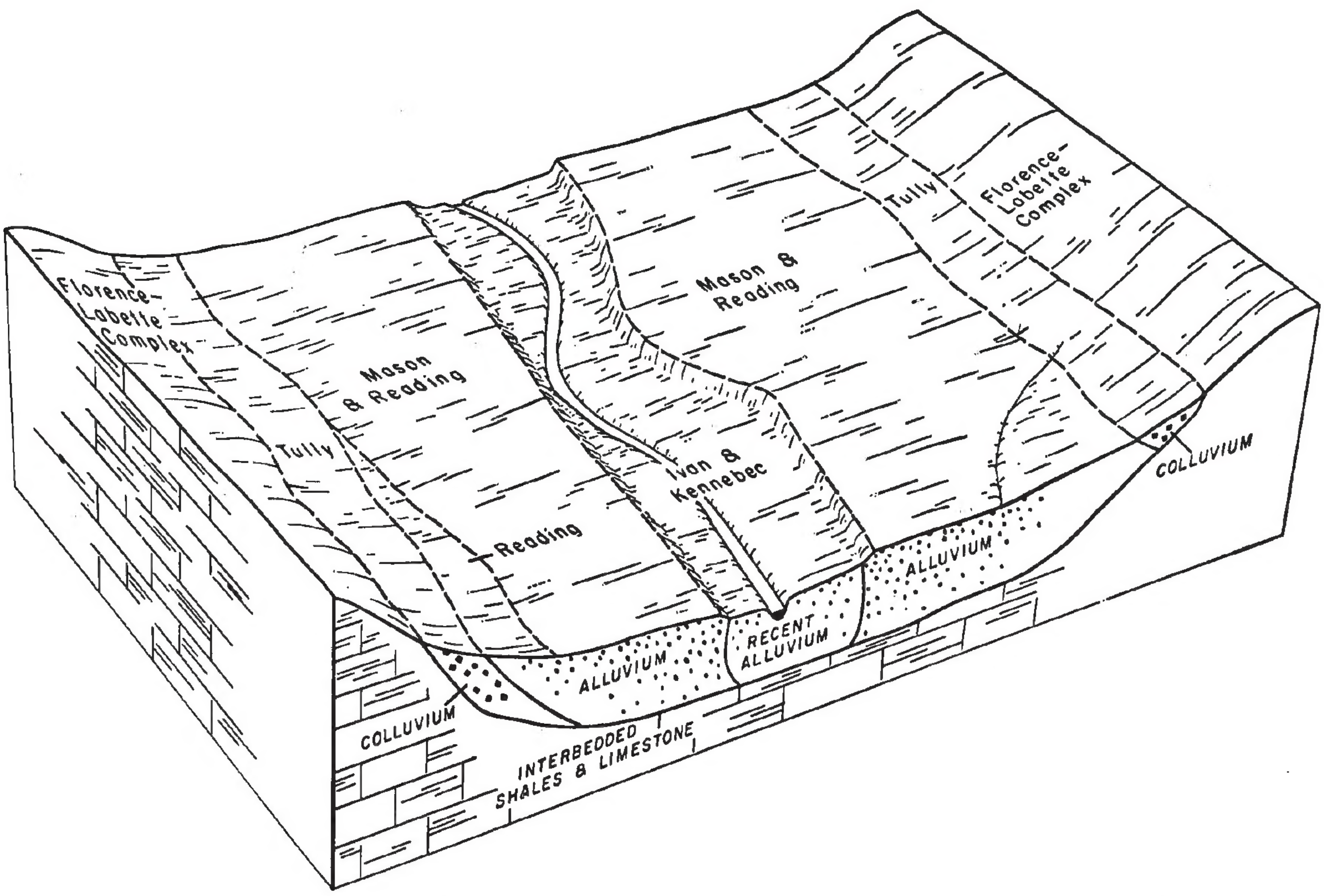

Figure 7.—**Typical pattern of soils and underlying material in association 4. In many places Florence and Labette soils, closely intermingled and mapped together, border soils of this association.**

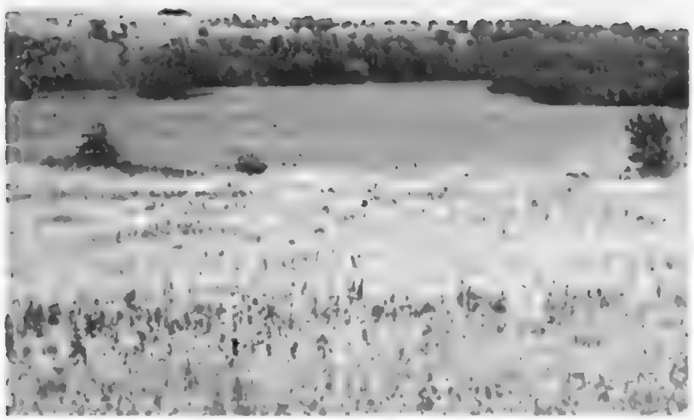

Figure 8.—**Typical area of association 4. A Tully soil that has slopes of 3 to 7 percent is in the foreground; nearly level Mason and Reading soils are in the center of the picture; Ivan and Kennebec soils, along Diamond Creek, are in the area adjacent to the trees; and Florence and Labette soils, closely intermingled and mapped together, occupy the side slopes in the background.**

on uplands, and wheat is not well suited to Ivan and Kennebec soils. The more sloping soils in a few areas are eroded. Proper utilization of crop residue is the main concern in managing the nearly level soils. Controlling erosion and maintaining tilth and fertility are the main concerns of management where the soils are more sloping.

5. Irwin-Kipson-Sogn association

Deep, gently sloping and sloping soils that have a clayey subsoil, and shallow, gently sloping to moderately steep soils that are loamy throughout; on uplands

This association consists of gently sloping to moderately steep soils that formed in clayey and loamy material (fig. 9). About half the acreage is of gently sloping soils, and half is of sloping to moderately steep soils. This association makes up about 14 percent of the county.

Moderately well drained or well drained Irwin soils make up about 50 percent of the association. These soils have a surface layer of dark grayish-brown silty clay loam about 10 inches thick. The subsoil is very firm, brown silty clay about 50 inches thick. Most of the Irwin soils are gently sloping and sloping.

Shallow Kipson and Sogn soils make up about 30 percent of the association. The Kipson soils, which are well drained, have a surface layer of dark grayish-brown silt loam about 8 inches thick. The next layer is friable, grayish-brown silt loam about 7 inches thick. Pale-yellow, highly calcareous silty shale is at a depth of 15 inches. Kipson soils are gently sloping to moderately steep and occur below Sogn soils on the landscape.

The Sogn soils are somewhat excessively drained and have a surface layer of very dark gray silty clay loam about 8 inches thick. Below the surface layer is level-bedded, hard limestone that contains a few cracks where roots can penetrate. Sogn soils are gently sloping to sloping and occur above the Kipson soils.

Tully soils that formed in colluvium are below areas of Kipson and Sogn soils and make up about 8 percent of the association. Labette and Dwight soils are above the Kipson and Sogn soils and make up about 12 percent of the association.

About 50 percent of the acreage in this association is cultivated; the rest is used for pasture or range. The soils are suited to most crops commonly grown in the county, except corn. In some cultivated areas the soils are eroded. Controlling erosion and maintaining tilth and fertility are the main concerns in managing these cultivated soils. Good grazing management helps to keep the areas used for range and pasture in good condition.

Descriptions of the Soils

In this section the soils of Morris County are described in detail. The procedure is to describe first the soil series and then the mapping units, or kinds of soil, in that series. Thus, to get full information on any one mapping unit, it is necessary to read both the description of that unit and the description of the soil series to which the unit belongs. The approximate acreage and proportionate extent of each soil mapped are shown in table 1.

Each soil series description contains a short narrative description of a profile considered representative of the series, and a much more detailed description of the same profile that scientists, engineers, and others can use in making highly technical interpretations. The colors described are for a dry soil, unless otherwise indicated.

The description of each mapping unit contains suggestions on how the soil can be managed. Other suggestions for managing soils under native grass are given in the section "Range Management." Suitability of the soils for trees and shrubs is discussed in the section "Use of the Soils for Woodland and Windbreaks." Behavior of soils used as sites for structures or as material for construction is discussed in the section "Engineering Uses of the Soils."

The names of some soils are unlike those appearing on recently published surveys in adjacent counties. This is the result of refinements in concepts of soil series in the application of the soil classification system.

Some of the terms used in the soil descriptions are defined in the Glossary, and some are defined in the section "How This Survey Was Made." At the back of this soil survey is the "Guide to Mapping Units," which lists the mapping units in the county and shows the capability unit, range site, woodland suitability group, and windbreak suitability group each mapping unit is in, and the page where each of these groups is described.

Alluvial Land

Alluvial land, a miscellaneous land type, is dominantly silty clay loam in Morris County, although the texture ranges from gravelly silt loam to silty clay. In this county this miscellaneous land type is mapped only with Reading soils.

Alluvial land and Reading soils (0 to 3 percent slopes) (Ar).—This mapping unit is on narrow bottom lands in upland drainageways (fig. 10). The areas are dissected by meandering stream channels and are frequently flooded. They range from about 100 to 500 feet in width.

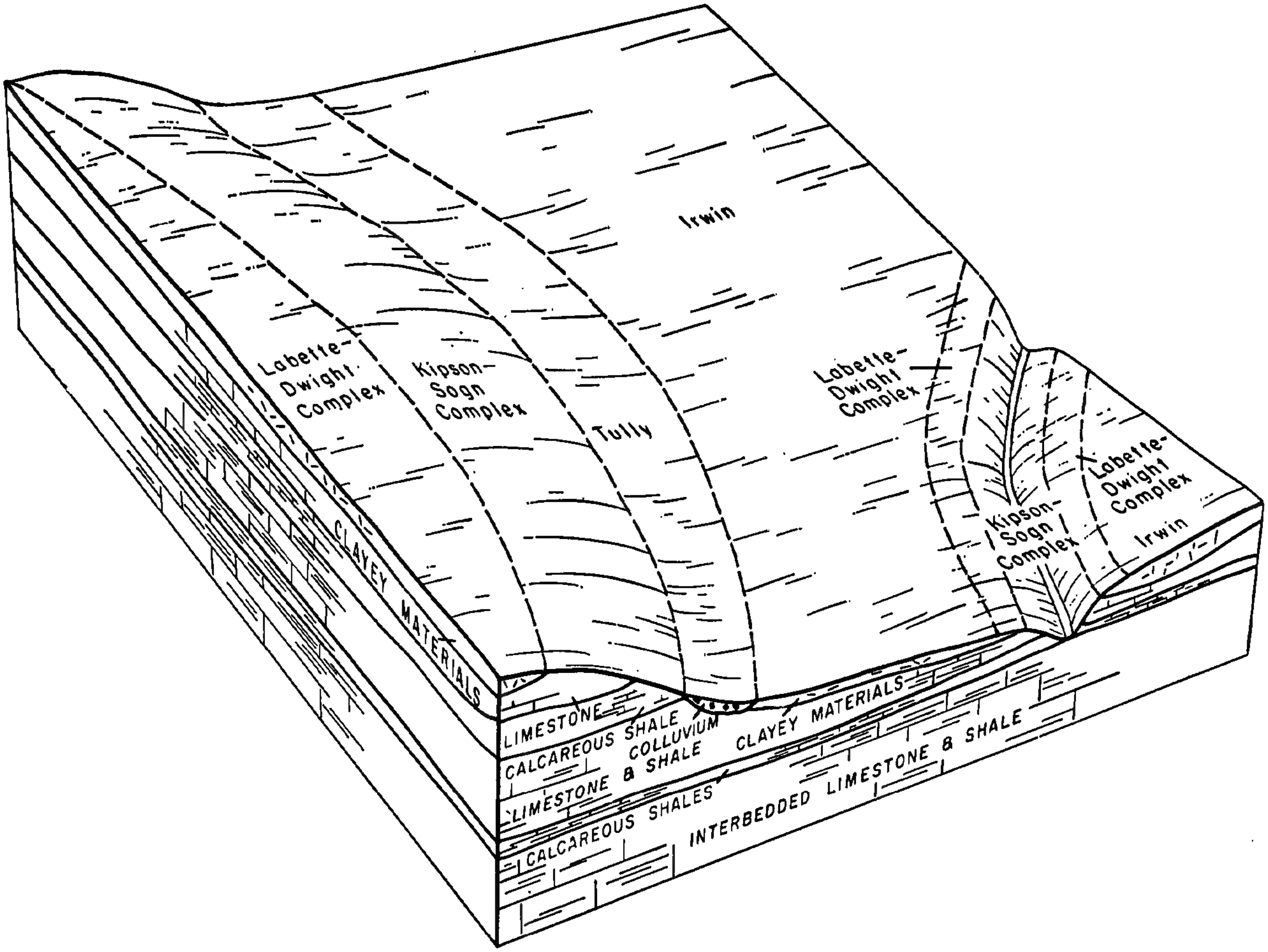

Figure 9.—**Typical pattern of soils and underlying material in association 5.**

Alluvial land occupies about 75 percent of the acreage, and Reading soils occupy about 25 percent. The Reading soils are at a higher elevation than Alluvial land, and they are mostly along the bends of streams. Reading soils have a profile similar to the one described as representative for the Reading series, except that the subsoil contains gravel in some places.

The soils of this mapping unit absorb water readily. They store a large amount of water and hold it readily available for the use of plants. Nevertheless, because of the frequent flooding, the irregular topography, and the pebbles and small stones on the surface in places, these soils are not suited to cultivated crops.

These soils are among the best suited in the county to native range. The major management needs are control of weeds and brush and the maintenance and improvement of the native grasses. These soils also are suited to trees grown for windbreaks or timber and to wildlife habitat. (Capability unit VIw-1; Loamy Lowland range site; woodland suitability group 1; windbreak suitability group A)

Figure 10.—**Typical area of Alluvial land and Reading soils. Florence soils are on the adjacent side slopes.**

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Soil	Acres	Percent
Alluvial land and Reading soils	7, 862	1. 7
Chase silty clay loam	3, 400	. 8
Clime-Sogn complex, 5 to 20 percent slopes	9, 069	2. 0
Dwight silt loam, 1 to 3 percent slopes	18, 904	4. 2
Florence cherty silt loam, 5 to 15 percent slopes	26, 374	5. 8
Florence-Labette complex, 2 to 12 percent slopes	25, 943	5. 7
Irwin silty clay loam, 0 to 1 percent slopes	7, 858	1. 7
Irwin silty clay loam, 1 to 3 percent slopes	57, 753	12. 8
Irwin silty clay loam, 3 to 5 percent slopes	5, 935	1. 3
Irwin soils, 1 to 3 percent slopes, eroded	46, 017	10. 3
Irwin soils, 3 to 5 percent slopes, eroded	1, 811	. 4
Ivan and Kennebec silt loams	7, 979	1. 8
Kipson-Sogn complex, 3 to 15 percent slopes	17, 261	3. 8
Labette silty clay loam, 2 to 5 percent slopes	9, 310	2. 1
Labette-Dwight complex, 1 to 3 percent slopes	59, 712	13. 3
Labette-Sogn complex, 2 to 8 percent slopes	15, 581	3. 4
Ladysmith silty clay loam, 0 to 2 percent slopes	35, 971	7. 9
Ladysmith silty clay loam, 1 to 2 percent slopes, eroded	4, 976	1. 1
Mason and Reading silt loams, 0 to 1 percent slopes	28, 973	6. 4
Osage silty clay	319	(1)
Reading silt loam, 1 to 3 percent slopes	5, 994	1. 3
Smolan silt loam, 1 to 3 percent slopes	1, 421	. 3
Smolan silty clay loam, 2 to 6 percent slopes, eroded	1, 640	. 4
Tully silty clay loam, 3 to 7 percent slopes	23, 099	5. 1
Tully silty clay loam, 3 to 7 percent slopes, eroded	10, 135	2. 2
Tully soils, 5 to 15 percent slopes	15, 225	3. 4
Council Grove Reservoir	3, 280	. 7
Council Grove City Lake	434	. 1
Lake Kahola	200	(1)
Sewage Lagoon	44	(1)
Total	452, 480	100. 0

[1] Less than 0.1 percent.

Chase Series

The Chase series consists of moderately well drained, deep, nearly level soils on low stream terraces. These soils formed in clayey alluvium. They are occasionally flooded.

In a representative profile the surface layer is silty clay loam about 14 inches thick. This layer is grayish brown in the upper 7 inches and is dark gray in the lower 7 inches. The subsoil is about 30 inches thick. The upper 6 inches of the subsoil is dark-gray, firm heavy silty clay loam. The next 24 inches is very firm silty clay that is dark gray in the upper 12 inches and gray in the lower 12 inches. The substratum is light brownish-gray heavy silty clay loam that has distinct mottles of yellowish brown and very dark gray.

Chase soils have slow permeability and high available water capacity.

Representative profile of Chase silty clay loam, in a cultivated field, 1,200 feet north and 200 feet east of the center of sec. 30, T. 16 S., R. 9 E.:

Ap—0 to 7 inches, grayish-brown (10YR 5/2) silty clay loam, very dark brown (10YR 2/2) when moist; weak, fine, granular structure; hard when dry, friable when moist; few fine wormholes; neutral; abrupt, smooth boundary.

A1—7 to 14 inches, dark-gray (10YR 4/1) silty clay loam, black (10YR 2/1) when moist; moderate, medium and fine, granular structure; slightly hard when dry, friable when moist; many fine wormholes and worm casts; neutral; gradual, smooth boundary.

B1—14 to 20 inches, dark-gray (10YR 4/1) heavy silty clay loam, black (10YR 2/1) when moist; moderate, fine, subangular blocky structure; hard when dry, firm when moist; few fine wormholes and worm casts; slightly acid; gradual, smooth boundary.

B21t—20 to 32 inches, dark-gray (10YR 4/1) silty clay, black (10YR 2/1) when moist; moderate, medium and fine, blocky structure; very hard when dry, very firm when moist; few fine wormholes; shiny surfaces on most peds; slightly acid; gradual, smooth boundary.

B22t—32 to 44 inches, gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) when moist; few nearly black (10YR 2/1) vertical streaks; few, fine, faint mottles of dark yellowish brown (10YR 4/4); moderate, medium, blocky structure; very hard when dry, very firm when moist; shiny faces on some peds; few black concretions; neutral; gradual, smooth boundary.

C—44 to 60 inches, light brownish-gray (10YR 6/2) heavy silty clay loam, dark grayish brown (10YR 4/2) when moist; few, fine, distinct mottles of yellowish brown (10YR 5/8) and very dark gray (10YR 3/1); massive; very hard when dry, very firm when moist; mildly alkaline.

The A horizon ranges from grayish brown to very dark gray in color and from 12 to 20 inches in thickness. Reaction ranges from medium acid to neutral. The B1 horizon ranges from 4 to 10 inches in thickness. The combined thickness of the B21t and B22t horizons ranges from 20 to 32 inches, and the color ranges from gray to dark grayish brown. Reaction of the B horizon is medium acid to neutral. The C horizon is silty clay loam to silty clay, and it ranges from light yellowish brown to dark gray. Reaction of the C horizon ranges from slightly acid to mildly alkaline.

Chase soils are closely associated with Osage, Mason, and Reading soils. They are better drained and have a coarser textured A horizon than Osage soils. Chase soils are finer textured in all horizons than Mason and Reading soils.

Chase silty clay loam (0 to 1 percent slopes) (Ch).—This is the only Chase soil mapped in Morris County. It is in areas of irregular shape on low terraces along the major streams.

Included with this soil in mapping were small areas of Mason and Reading silt loams, 0 to 1 percent slopes, and small areas of Osage silty clay. In most places these included Mason and Reading soils are in narrow bands that are closer to the stream than are the areas of Chase soil. The Osage soil occupies small, nearly level tracts or slight depressions where sediment has been deposited by backwater.

This Chase soil takes in water and releases it readily if the surface layer is kept in good tilth. The surface layer is granular and is easily tilled. Permeability is slow, and runoff is slow.

Slow permeability and occasional flooding are the main limitations to use of this soil for crops. Maintaining fertility and keeping the soil in good tilth are management needs in addition to providing protection from flooding.

This soil is suited to all the crops commonly grown in the county. Wheat, alfalfa, sorghum, and soybeans are the main crops. Any crop that produces sufficient residue of leaves and stems can be grown every year if the residue is returned to the soil and if weeds and insects are controlled. The residue helps to keep the surface layer in good tilth, so that it absorbs water readily and is easier to till.

Nearly all the acreage is cultivated, but this soil is also suited to tame and native grasses. In addition, it is suited to trees grown for windbreaks or timber and to wildlife habitat. (Capability unit IIw-2; Loamy Lowland range site; woodland suitability group 3; windbreak suitability group A)

Clime Series

The Clime series consists of moderately well drained or well drained, moderately deep, sloping to moderately steep soils on uplands. These soils formed in material weathered from calcareous shale.

In a representative profile the surface layer is very dark gray light silty clay about 8 inches thick. The subsoil is firm, dark-gray silty clay about 9 inches thick. The substratum is pale-olive silty clay that has common mottles of olive yellow, light gray, and dark grayish brown. Clayey shale is at a depth of about 30 inches.

Clime soils have moderately slow permeability and low to moderate available water capacity.

Representative profile of Clime silty clay in an area of Clime-Sogn complex, 5 to 20 percent slopes, in native grass, 2,200 feet east and 800 feet north of southwest corner of sec. 21, T. 17 S., R. 9 E.:

A1—0 to 8 inches, very dark gray (10YR 3/1) light silty clay, black (10YR 2/1) when moist; moderate, fine, granular structure; hard when dry, firm when moist; many roots; mildly alkaline; weakly calcareous; clear, smooth boundary.

B2—8 to 17 inches, dark-gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) when moist; moderate, fine and medium, subangular blocky structure; hard when dry, firm when moist; common fine roots; few limestone chips less than one-fourth inch in diameter; common worm cast granules that have the color of the C horizon; moderately alkaline; calcareous; gradual, smooth boundary.

C—17 to 30 inches, pale-olive (5Y 6/3) silty clay; olive (5Y 5/3) when moist; common, fine mottles of olive yellow (2.5Y 6/6), light gray (5Y 7/2), and dark grayish brown (2.5Y 4/2); massive; hard when dry, firm when moist; few, fine roots; few fine and medium limestone chips and fragments; moderately alkaline; calcareous; diffuse, smooth boundary.

R—30 to 46 inches, light-gray (5Y 7/2) clayey shale, only slightly altered, olive gray (5Y 5/2) when moist; common, distinct mottles of pale yellow (5Y 7/4) and yellow (5Y 7/6); weak, platy structure; very firm when moist; moderately alkaline; calcareous.

The A horizon ranges from 5 to 10 inches in thickness and from very dark gray to grayish brown in color. Texture ranges from heavy silty clay loam to silty clay. Reaction is mildly alkaline or moderately alkaline. The B horizon is 6 to 12 inches thick and ranges from dark gray to grayish brown. The C horizon is 10 to 20 inches thick and has variable colors that relate to the underlying shale. Depth to the R horizon ranges from 20 to 40 inches. Depth to free carbonates is less than 8 inches.

Clime soils are associated with Sogn, Kipson, and Tully soils. They are deeper and finer textured than either Sogn or Kipson soils. They are less deep, are more alkaline in all horizons, and have a finer textured A horizon than Tully soils.

In Morris County, Clime soils are mapped only in a complex with Sogn soils.

Clime-Sogn complex, 5 to 20 percent slopes (Cs).—This complex consists mainly of Clime silty clay, Sogn silty clay loam, and limestone rock outcrop. The Clime soil makes up about 45 percent of the acreage; Sogn soil and rock outcrop, about 20 percent; and Kipson, Tully, Labette, Irwin, and Dwight soils make up the remaining 35 percent. Also in this complex is a minor acreage of soils that have slopes in excess of 25 percent. They are in a few places on the south side of the Neosho River and Four Mile Creek.

The Clime and Sogn soils are in alternating bands separated by rock outcrop. Sogn soils are more gently sloping than Clime soils. The Kipson, Tully, and Irwin soils are downslope from Clime soils. Labette and Dwight soils are above the Sogn soils.

Soils in this complex take in water readily if the surface layer has a good cover of vegetation. The amount of water stored is limited by the depth of soil over limestone or calcareous shale. The soils are subject to minor erosion by water, especially where the surface soil has been exposed by fire or where grass cover is thin. The chief management needs are control of erosion and maintenance and improvement of desirable range plants.

This complex is used mostly for range, but it also is suited to trees grown for windbreaks and to wildlife habitat. (Both soils are in capability unit VIe-1; Clime soil is in Limy Upland range site, and Sogn soil is in Shallow Limy range site; neither soil is in a woodland suitability group; Clime soil is in windbreak suitability group D, and Sogn soil is in windbreak suitability group G)

Dwight Series

The Dwight series consists of deep, moderately well drained, gently sloping soils on uplands. These soils formed in clay residuum or in clayey sediment similar to clay residuum.

In a representative profile the surface layer is dark-gray silt loam about 5 inches thick. The subsoil is about 47 inches thick. It is extremely firm, dark grayish-brown and grayish-brown clay in the upper 17 inches and very firm, brown and grayish-brown silty clay in the lower 30 inches. Below the subsoil is cherty limestone.

Dwight soils have high available water capacity and very slow permeability.

Representative profile of Dwight silt loam, 1 to 3 percent slopes, in native grass, 100 feet south and 150 feet west of center of sec. 26, T. 17 S., R. 8 E.:

A1—0 to 5 inches, dark-gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; many fine roots; medium acid; abrupt, smooth boundary.

B21t—5 to 14 inches, dark grayish-brown (10YR 4/2) clay, very dark brown (10YR 2/2) when moist; a few black stains on some ped surfaces; moderate, medium, columnar structure breaking to weak, fine, blocky structure; extremely hard when dry, extremely firm when moist; few, fine, flattened roots concen-

trated along ped surfaces; slightly acid; clear, smooth boundary.

B22t—14 to 22 inches, grayish-brown (10YR 5/2) clay, dark grayish-brown (10YR 4/2) when moist; weak, medium, blocky structure; extremely hard when dry, extremely firm when moist; few black stains; few fine chips of limestone and chert; moderately alkaline; diffuse, smooth boundary.

B31—22 to 36 inches, brown (10YR 5/3) silty clay, dark brown (10YR 4/3) when moist; common, fine and medium, distinct mottles of reddish yellow (7.5YR 6/6) and light gray (10YR 7/2); moderate, fine, blocky structure; very hard when dry, very firm when moist; few fine chips of chert; few calcium carbonate and iron-manganese concretions; moderately alkaline; clear, smooth boundary.

B32—36 to 52 inches, grayish-brown (10YR 5/2) silty clay, dark grayish-brown (10YR 4/2) when moist; many, fine and medium, distinct mottles of strong brown (7.5YR 5/6); crushed color is dark brown (7.5YR 3/2) when moist, brown (7.5YR 4/4) when dry; moderate, fine, blocky structure; very hard when dry, very firm when moist; few black stains on ped surfaces; few fine chips of chert; moderately alkaline; abrupt, smooth boundary.

R—52 inches, cherty limestone.

The A horizon ranges from 2 to 7 inches in thickness, but it is mainly about 5 inches thick. It ranges from dark gray to dark grayish brown. Texture is silt loam in uncultivated areas; it ranges from silt loam to silty clay in cultivated areas. Structure is mainly weak, fine, granular, except for the uppermost 1 to 2 inches, where it is weak, thin, and platy in many places. Reaction ranges from medium acid to neutral. The B horizon ranges from 25 to 47 inches in thickness. Texture is clay or silty clay, and color ranges from very dark grayish brown to brown. Reaction in this horizon ranges from slightly acid to moderately alkaline. In places the B horizon is underlain by a C horizon. Depth to limestone, cherty limestone, or shale ranges from 40 to 60 inches.

Dwight soils are similar to the associated Irwin and Ladysmith soils. They also are closely associated with Labette soils. The Dwight soils have a thinner A horizon than Ladysmith and Irwin soils and a more abrupt textural boundary between the A and B2t horizons. Dwight soils have columnar structure in the upper part of the B2t horizon, which the Ladysmith and Irwin soils do not have. Dwight soils are deeper than Labette soils and have a thinner, less granular A horizon.

Dwight silt loam, 1 to 3 percent slopes (Dh).—This soil is on rather narrow divides above Florence or Sogn soils.

Included in mapping were small areas of Labette, Irwin, and Ladysmith soils. The Irwin and Ladysmith soils are at slightly higher elevations, and the Labette soils are in the same landform as Dwight soils. Also included, in cultivated fields, are areas of a soil that has a surface layer of silty clay.

This Dwight soil takes in water very slowly and loses much water by runoff. Some surface crusting is evident in most cultivated areas. Droughtiness is common during periods of low rainfall. Erosion is a hazard where the soils are used for crops and are not protected. Maintaining fertility and keeping the soil in good tilth are additional management concerns.

Terraces and contour farming help to control erosion where this soil is used for crops. Many farmers use a cropping sequence of 2 or 3 years of wheat followed by sweet clover. The sweet clover increases the intake of water and helps maintain fertility and structure of the soil.

About 30 percent of the acreage is used for field crops. This soil is better suited to wheat than to other crops. Corn, forage sorghum, soybeans, and smooth brome generally are not grown, because of droughts in summer and the slow release of water by the clay subsoil. This soil is also suited to use as native range, to growing trees for windbreaks, and to wildlife habitat. About 70 percent of the acreage is in native grass. The principal management needs in these areas are maintaining and improving the native grasses. (Capability unit IVe-2; Claypan range site; not in a woodland suitability group; windbreak suitability group E)

Florence Series

The Florence series consists of deep, well-drained, sloping and moderately steep, cherty soils on uplands. These soils formed over cherty limestone and shale.

In a representative profile (fig. 11) the surface layer is dark grayish brown and is about 11 inches thick. The upper 4 inches of this layer is cherty silt loam, and the lower 7 inches is cherty silty clay loam. The subsoil, which extends to a depth of 44 inches, is brown, firm, cherty heavy silty clay loam in the upper 4 inches and dark reddish-brown, very firm coarse cherty clay in the lower 29 inches. Below the subsoil is cherty limestone bedrock that has a few vertical and lateral fractures filled with red clay.

Florence soils have moderately slow permeability and low available water capacity.

Representative profile of Florence cherty silt loam, 5 to 15 percent slopes, in native grass, 2,200 feet north and 800 feet east of center of sec. 7, T. 17 S., R. 8 E.:

Figure 11.—**Profile of a Florence cherty silt loam.**

A11—0 to 4 inches, dark grayish-brown (10YR 4/2) cherty silt loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; many roots; chert fragments 1/4 inch to 2 inches in diameter make up about 15 percent of the mass; neutral; clear, smooth boundary.

A12—4 to 11 inches, dark grayish-brown (10YR 4/2) cherty silty clay loam, very dark brown (10YR 2/2) when moist; moderate, medium and fine, granular structure; slightly hard when dry, friable when moist; many roots; chert fragments 1/4 inch to 4 inches in diameter make up about 80 percent of the mass; slightly acid; gradual, smooth boundary.

B1—11 to 15 inches, brown (7.5YR 4/2) cherty heavy silty clay loam, dark brown (7.5YR 3/2) when moist; strong, fine and very fine, subangular blocky structure; hard when dry, firm when moist; many roots; chert fragments as much as 4 inches in diameter make up about 80 percent of the mass; slightly acid; gradual, smooth boundary.

B2t—15 to 44 inches, dark reddish-brown (2.5YR 3/4) coarse cherty clay, dark red (2.5YR 3/6) when moist; strong, medium and fine, blocky structure; extremely hard when dry, very firm when moist; common roots; common dark stains and fine black concretions; chert fragments as large as 4 by 8 inches make up about 80 percent of the mass; slightly acid; clear, irregular boundary.

R—44 to 60 inches, cherty limestone that has a few vertical and lateral fractures filled with red clay.

The A11 horizon ranges from 3 to 6 inches in thickness and is dark gray or dark grayish brown. The A12 horizon ranges from 4 to 10 inches in thickness and is dark grayish brown or dark gray. Reaction in the A horizon is slightly acid or neutral. The B horizon ranges from 25 to 43 inches in thickness. It is brown or reddish brown in the upper part and dark reddish brown in the lower part. Reaction in the B horizon is slightly acid or neutral. Chert fragments make up more than 50 percent of the mass in all horizons except the A11 horizon. The A11 horizon is 0 to 40 percent chert fragments. Depth to bedrock ranges from 40 to 60 inches.

Florence soils are associated with Labette and Tully soils. They contain more chert in the B horizon than those soils and are deeper than Labette soils.

Florence cherty silt loam, 5 to 15 percent slopes (Fc).—This soil is in narrow but continuous areas that extend for more than a mile in places. It has both plane and convex slopes. This soil has the profile described as representative for the series.

Included in mapping were small areas of Tully and Dwight soils. Also included, in the southern part of the county, were small areas of a soil that has a profile similar to that of this soil, except that the surface layer is thicker and the lower part of the surface layer is light colored. This included soil is nearly level and is on narrow ridgetops. The included Dwight soil is gently sloping and is in areas above this Florence soil. The included Tully soils formed in colluvium in areas below the Florence soils (fig. 12).

This Florence soil takes in water well if a good cover of grass is maintained. It releases water readily for plant use, but the amount of water stored is limited by soil depth and the amount of chert. Runoff is medium to rapid, depending on slope.

This soil is better suited to range than to field crops or tame pasture, and all of the acreage is used for range. The principal management need is maintaining or improving the native grasses. This soil also is suited to wildlife habitat and to trees for windbreaks. (Capability unit VIe-2; Loamy Upland range site; not in a woodland suitability group; windbreak suitability group F)

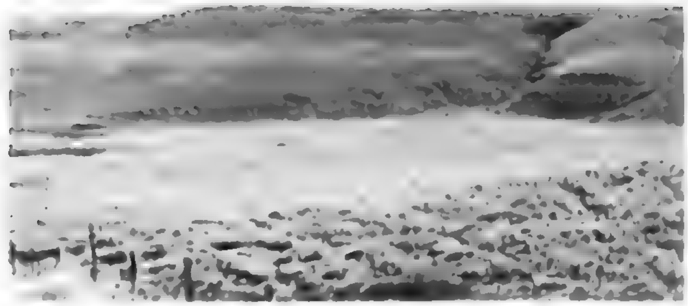

Figure 12.—Florence and Tully soils in an area of Florence cherty silt loam, 5 to 15 percent slopes. Florence soils are on the ridges, and Tully soils are immediately downslope.

Florence-Labette complex, 2 to 12 percent slopes (Fe).—This complex consists of about 20 percent Florence soils and 23 percent Labette soils. Soils similar to Florence cherty silt loam, except that the depth to bedrock ranges from 25 to 40 inches, make up 28 percent of the complex; 15 percent is soils similar to Labette silty clay loam, except that the depth to hard limestone is less than 20 inches; and 14 percent is Dwight, Sogn, and Tully soils.

The soils in this complex occur in narrow, mostly continuous areas that, in places, extend for more than a mile. The soils have both plane and convex slopes, and they are at a lower elevation than Florence cherty silt loam, 5 to 15 percent slopes.

The more gently sloping Labette soils are in the higher part of this complex, and Florence soils are in the lower part. Dwight and Sogn soils are also in the higher part of this complex, and Tully soils are in the lower part.

The soils in this complex take in water readily if the surface layer has a good cover of vegetation. The stored water is readily available for plant use, but the volume of water stored is limited by the depth to limestone and the amount of chert in the profile. Runoff is medium to rapid, depending on slope.

The soils in this mapping unit are better suited to native range than to field crops or tame pasture. The chief management need is maintaining or improving the native grasses. These soils also are suited to wildlife habitat and to trees for windbreaks. (Both soils are in capability unit VIe-2; Loamy Upland range site; neither soil is in a woodland suitability group; Florence soils are in windbreak suitability group F, and Labette soils are in windbreak suitability group C)

Irwin Series

The Irwin series consists of moderately well drained or well drained, deep, nearly level to sloping soils on uplands. These soils formed in shale residuum or clayey sediment of similar characteristics.

In a representative profile the surface layer is about 10 inches of dark grayish-brown silty clay loam. The subsoil is very firm, brown silty clay about 50 inches thick.

Irwin soils have high available water capacity and very slow permeability.

Representative profile of Irwin silty clay loam, 1 to 3 percent slopes, in a cultivated field, 1,100 feet west and 650 feet north of the center of sec. 3, T. 14 S., R. 6 E.:

A1—0 to 10 inches, dark grayish-brown (10YR 4/2) light silty clay loam, very dark brown (10YR 2/2) when moist; weak to moderate, fine, granular structure; slightly hard when dry, friable when moist; few roots; medium acid; clear, smooth boundary.

B21t—10 to 24 inches, brown (7.5YR 4/3) silty clay, dark brown (7.5YR 3/2) when moist; few, fine, faint mottles of strong brown (7.5YR 5/6) and a few black specks; moderate, coarse and medium, blocky structure breaking to weak, fine, blocky structure when moist; very hard when dry, very firm when moist; few fine roots concentrated along ped surfaces; slightly acid; gradual, smooth boundary.

B22t—24 to 34 inches, brown (7.5YR 5/3) silty clay, brown (7.5YR 4/3) when moist; few, fine, faint mottles of strong brown (7.5YR 5/6); moderate, medium, blocky structure; very hard when dry, very firm when moist; few roots concentrated along vertical ped surfaces; neutral; gradual, smooth boundary.

B31—34 to 46 inches, brown (7.5YR 5/3) silty clay, brown (7.5YR 4/3) when moist; weak, medium, blocky structure breaking to weak, fine, blocky structure when moist; very hard when dry, very firm when moist; mildly alkaline; gradual, smooth boundary.

B32—46 to 60 inches, brown (7.5YR 4/3) silty clay, dark brown (7.5YR 3/2) when moist; weak, fine, blocky structure; very hard when dry, very firm when moist; mildly alkaline.

The A1 horizon ranges from 7 to 13 inches in thickness. Its texture ranges from heavy silt loam to silty clay loam, but in most places it is silty clay loam. Its color ranges from grayish brown to dark grayish brown. Reaction ranges from medium acid to neutral. The B horizon ranges from silty clay to clay in texture, from 18 to 50 inches in thickness, and from medium acid to mildly alkaline in reaction. Color ranges from brown to dark grayish brown. In places a C horizon underlies the B horizon. The C horizon is of variable color and commonly is coarsely mottled.

In Morris County the eroded Irwin soils are not darkened so deeply as the defined range for the series, because erosion has removed part or all of the original surface layer.

Irwin soils are similar to the Ladysmith, Dwight, Labette, Smolan, and Tully soils, with which they are associated. They are less dark in the B21 horizon than Ladysmith soils. They have a thicker A horizon than Dwight soils, and a less abrupt textural boundary between the A and B2t horizons. They do not have the columnar structure that occurs in the upper part of the B2t horizon of Dwight soils. Irwin soils are deeper than Labette soils, have a more abrupt textural boundary between the A and B2t horizons, and are less red in the B2t horizon. They have a thinner A horizon and a more abrupt textural boundary between the A and B2t horizons than Tully soils. They have a thinner A horizon and a finer textured B horizon than Smolan soils.

Irwin silty clay loam, 0 to 1 percent slopes (Ic).—This nearly level soil is on moderately broad ridgetops. Included with this soil in mapping were small areas of Ladysmith soils in small, shallow depressions. A few sinkholes occur and are shown on the soil map by symbol.

This Irwin soil has a clayey subsoil that releases water slowly for plant use. Runoff is slow, and water commonly ponds for short periods after heavy rains. Management is needed to maintain good soil structure and fertility and to increase the intake of water. Soil blowing is a hazard if the soil is left bare in winter and spring. Good management of crop residue helps to maintain good tilth in the surface layer, to increase the intake of water, and to protect against soil blowing. Growing deep-rooted legumes also improves the intake of water.

Wheat and grain sorghum are the main crops, but alfalfa and soybeans also are grown. Corn generally is not grown, because of the droughts in summer and the slow release of water by the clayey subsoil.

Most areas are used for cultivated crops, but this soil is also suited to native and tame perennial grasses, to trees for windbreaks, and to wildlife habitat. (Capability unit IIs–1; Clay Upland range site; not in a woodland suitability group; windbreak suitability group C)

Irwin silty clay loam, 1 to 3 percent slopes (Id).—This soil is on plane to weakly convex side slopes near the tops of broad upland ridges. It has the profile described as representative for the Irwin series.

Included with this soil in mapping were small areas of Labette and Dwight soils and of a nearly level Ladysmith soil. The Labette and Dwight soils occur where the clayey sediment thins to less than 60 inches over bedrock. Also included were a few areas that are eroded. These eroded areas are about 1 to 4 acres in size and are shown on the soil map by a special symbol. In some places the profile of this Irwin soil contains less clay and more silt in the subsoil than is typical.

Runoff is medium. The clayey subsoil releases water slowly for plant use. Management is needed to maintain good soil structure and fertility and to increase the intake of water. Water erosion is the main hazard, but soil blowing also is a hazard if this soil is left bare in winter and spring.

Terraces and contour farming help to control erosion on this soil. Good management of crop residue also helps to control erosion, increases the intake of water, and helps to maintain good tilth in the surface layer. Growing deep-rooted legumes also improves the intake of water.

Wheat and grain sorghum are the main crops, but alfalfa and soybeans also are grown. Corn generally is not grown, because of the droughts in summer and the slow release of water by the clayey subsoil.

About 40 percent of the acreage is in native perennial grasses, and about 60 percent is cultivated. The principal management need where this soil is used for native range is maintaining or improving the native grasses. This soil also is suited to tame perennial grasses, to trees for windbreaks, and to wildlife habitat. (Capability unit IIIe–1; Clay Upland range site; not in a woodland suitability group; windbreak suitability group C)

Irwin silty clay loam, 3 to 5 percent slopes (Ie).—This soil is in narrow bands in association with Irwin silty clay loam, 1 to 3 percent slopes. It also is along some small upland drainageways.

Included with this soil in mapping were small areas of Tully and Labette soils in pockets adjacent to the drainageways. Also included were areas of Irwin soils, 1 to 4 acres in size, that have been eroded. These small eroded areas are shown on the map by a symbol.

Runoff is rapid, and the hazard of water erosion is severe. Management is needed to maintain soil structure and fertility and to increase the intake of water when the soil is tilled.

Terraces and contour farming help to control erosion. Good management of crop residue helps to control erosion, increases the intake of water, and helps to keep the surface layer in good tilth. Growing deep-rooted legumes also improves the intake of water.

Wheat and grain sorghum are the main crops, but alfalfa also is grown. Corn generally is not grown, because of the droughts in summer and the slow release of water by the clayey subsoil.

About 75 percent of the acreage is in native grass, and 25 percent is used for cultivated crops. This soil is better suited to native grass than to field crops or tame pasture. If this soil is used for native range, the principal management needed is maintaining or improving the native grasses. This soil also is suited to tame perennial grasses, trees for windbreaks, and wildlife habitat. (Capability unit IIIe–6; Clay Upland range site; not in a woodland suitability group; windbreak suitability group C)

Irwin soils, 1 to 3 percent slopes, eroded (In).—These soils are on side slopes near the tops of broad upland ridges. The slopes are plane or weakly convex. The profile is similar to the one described as representative for the Irwin series, but in about 60 percent of the acreage the original surface layer has been thinned or removed by erosion and the present surface layer is silty clay about 5 inches thick. In the remaining 40 percent, the surface layer is about equal amounts of heavy silty clay loam and silty clay loam. Shallow gullies are common where these soils are not protected.

Included in mapping were small areas of Dwight, Labette, and Ladysmith soils.

These Irwin soils lack the tilth and productivity of the less eroded Irwin soils. Their surface layer crusts badly, and a stand of plants commonly is difficult to obtain. These soils are difficult to till, and they can be worked only within a narrow range of moisture content. Good management is needed to maintain satisfactory soil structure and fertility, as well as to increase intake of water. Water erosion is the main hazard.

Terraces and contour farming help to control erosion on these soils. Growing deep-rooted legumes improves intake of water. Good management of crop residue helps to control erosion, and it reduces crusting, increases the intake of water, and helps to maintain good tilth of the surface layer.

Wheat, grain sorghum, and alfalfa are the main crops. Corn and soybeans generally are not grown, because of the droughts in summer and the slow release of water by the clayey subsoil. Much of the acreage is used for cultivated crops, but these soils also are suited to native grasses, trees for windbreaks, and wildlife habitat. (Capability unit IIIe–3; Claypan range site; not in a woodland suitability group; windbreak suitability group E)

Irwin soils, 3 to 5 percent slopes, eroded (Io).—These soils are along small upland drainageways and in narrow bands in association with Irwin silty clay loam, 1 to 3 percent slopes. The profile is similar to the one described as representative for the Irwin series, but the original surface layer has been thinned or removed by erosion in about 70 percent of the acreage and the present surface layer is silty clay about 5 inches thick. In the remaining 30 percent, the surface layer has about equal amounts of heavy silty clay loam and silty clay loam. Shallow gullies are common where these soils are not protected.

Included in mapping were small areas of Labette and Tully soils.

These soils lack the tilth and productivity of the less eroded Irwin soils. The surface crusts badly, and a stand of plants commonly is difficult to obtain. These soils are difficult to till and can be worked only within a narrow range of moisture content. Surface runoff is rapid, and the hazard of water erosion is severe. Management is needed to maintain soil structure and fertility and to increase the intake of water.

Terraces and contour farming help to control erosion. Good management of crop residue also helps to control erosion, increases the intake of water, and helps to maintain good tilth of the surface layer. Growing deep-rooted legumes also improves the intake of water.

Wheat is the main crop. A small amount of grain sorghum and alfalfa also is grown. Much of the acreage is cultivated. Some areas that were formerly cultivated have been allowed to reseed naturally, but they contain few desirable species of grass. These soils also are suited to native grasses, trees for windbreaks, and wildlife habitat. (Capability unit IVe–1; Claypan range site; not in a woodland suitability group; windbreak suitability group E)

Ivan Series

The Ivan series consists of deep, well-drained, nearly level, calcareous soils on flood plains. These soils occur in the frequently flooded, low bottom areas along major stream valleys. They formed in recent, calcareous silty alluvium.

In a representative profile the surface layer is dark grayish-brown silt loam about 16 inches thick. The next layer is friable, grayish-brown silt loam about 14 inches thick. The substratum is brown silt loam.

Ivan soils have moderate permeability and high available water capacity. The water table is normally below a depth of 8 feet, but it is closer to the surface during periods of flooding.

Representative profile of Ivan silt loam in an area of Ivan and Kennebec silt loams, in a cultivated field, 2,250 feet west and 100 feet south of northeast corner of sec. 5, T. 14 S., R. 6 E.:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; weak, fine, granular structure; hard when dry, friable when moist; many worm casts; calcareous; mildly alkaline; abrupt, smooth boundary.

A1—7 to 16 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; many fine wormholes and worm casts; calcareous; moderately alkaline; gradual, smooth boundary.

AC—16 to 30 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium and fine, granular structure; hard when dry, friable when moist; many fine wormholes and worm casts; calcareous; moderately alkaline; gradual, smooth boundary.

C—30 to 60 inches, brown (10YR 5/3) silt loam, dark brown (10YR 3/3) when moist; massive; slightly hard when dry, friable when moist; contains thinly strati-

fied, pale-brown (10YR 6/3) lenses of silt loam; calcareous; moderately alkaline.

The A horizon ranges from 12 to 25 inches in thickness. Texture is mostly silt loam but ranges to silty clay loam. Color is very dark gray to grayish brown. In many places the AC horizon has thinly stratified lenses of darker or lighter colored silt loam or silty clay loam. Ranges in color and texture are like those of the A horizon. The C horizon ranges from loam to silty clay loam. Its color ranges from dark gray to brown. In many places this horizon has thin lenses of pale-brown silt loam. In most areas all horizons are calcareous, but a few areas are noncalcareous to a depth of 10 inches.

Ivan soils are associated with Mason, Reading, and Kennebec soils. They lack the B2t horizon of Mason and Reading soils. They are more alkaline throughout the profile than Kennebec soils.

In this county Ivan soils are mapped only with Kennebec soils.

Ivan and Kennebec silt loams (0 to 1 percent slopes) (Iv).—Soils of this mapping unit are on first bottoms along major streams, where they are frequently flooded. The Ivan soils are dominant on the lower reaches of Diamond Creek, Clarks Creek, and the Neosho River. The Kennebec soils are dominant along the upper reaches of most major streams. In other areas the Ivan and Kennebec soils occur together in nearly equal amounts, but Ivan soils are nearer to the stream channel.

Included in mapping were minor areas of Mason and Reading soils.

The soils in this mapping unit are friable and easily tilled. They absorb and store water well and release it readily for plant use. Runoff is slow. Flooding is the main hazard.

These soils are suited to most of the crops commonly grown in the county. Corn, sorghum, and bromegrass are the main crops. Wheat is not well suited, because the soils are subject to flooding while the crop is maturing. Any crop that produces sufficient vegetative growth can be grown year after year if the residue is returned to the soil and if weeds and insects are controlled.

Most of the acreage is used for cultivated crops, but the soils also are suited to tame and native grasses, to trees grown for windbreaks and timber, and to wildlife habitat. (Capability unit IIw-1; Loamy Lowland range site; woodland suitability group 1; windbreak suitability group A)

Kennebec Series

The Kennebec series consists of deep, well-drained, nearly level soils on flood plains. These soils are on low bottoms in valleys of the major streams, and they are frequently flooded. They formed in silty alluvium.

In a representative profile the surface layer is dark-gray silt loam about 24 inches thick. The next layer is friable, dark grayish-brown silt loam about 18 inches thick. The substratum is dark grayish-brown silt loam.

Kennebec soils have moderate permeability and high available water capacity. The water table is normally below a depth of 10 feet, but it can be closer to the surface in periods of flooding.

Representative profile of Kennebec silt loam in an area of Ivan and Kennebec silt loams, in a cultivated field, 650 feet east and 1,200 feet south of center of sec. 7, T. 16 S., R. 9 E.:

Ap—0 to 7 inches, dark-gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; many wormholes; neutral; abrupt, smooth boundary.

A1—7 to 24 inches, dark-gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) when moist; moderate, medium and fine, granular structure; slightly hard when dry, friable when moist; many fine wormholes; moderately alkaline; gradual, smooth boundary.

AC—24 to 42 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; moderate, medium and fine, granular structure; slightly hard when dry, friable when moist; many fine wormholes; moderately alkaline; gradual, smooth boundary.

C—42 to 60 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; massive; hard when dry, friable when moist; few fine wormholes; few very fine chert fragments; neutral.

The A horizon ranges from 18 to 30 inches in thickness. Texture is mostly silt loam but ranges to light silty clay loam. Color is very dark gray to grayish brown. Reaction ranges from medium acid to moderately alkaline. In the AC horizon the ranges in color, texture, and reaction are like those for the A horizon. In places the AC horizon has stratified lenses of darker or lighter colored silt loam or silty clay loam. The C horizon ranges from dark gray to brown and is mostly silt loam, but it ranges to silty clay loam. Reaction ranges from slightly acid to moderately alkaline, and this horizon is noncalcareous.

The reaction of these soils is less acid than the defined range for the series, but this difference does not alter their usefulness and behavior.

Kennebec soils are associated with Mason, Reading, and Ivan soils. They lack the B2t horizon of the Mason and Reading soils. They are less alkaline throughout the profile than Ivan soils.

In Morris County, Kennebec soils are mapped only in an undifferentiated group with Ivan soils.

Kipson Series

The Kipson series consists of gently sloping to moderately steep, well-drained soils on uplands. These soils formed in residuum from calcareous silty shale, and they are shallow over shale. Depth to shale ranges from 12 to 18 inches.

In a representative profile the surface layer is about 8 inches of dark grayish-brown silt loam. The next layer is friable, grayish-brown silt loam about 7 inches thick. Pale-yellow, highly calcareous silty shale is at a depth of 15 inches.

Kipson soils have very low available water capacity and moderate permeability.

Representative profile of Kipson silt loam in an area of Kipson-Sogn complex, 3 to 15 percent slopes, in native grass, 750 feet west and 35 feet north of southeast corner of sec. 20, T. 16 S., R. 5 E.:

A1—0 to 8 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; moderate, fine and very fine, granular structure; slightly hard when dry, friable when moist; many roots; moderately alkaline; calcareous; gradual, smooth boundary.

AC—8 to 15 inches, grayish-brown (2.5Y 5/2) heavy silt loam, very dark grayish brown (2.5Y 3/2) when moist; few worm granules of dark gray (10YR 4/1); moderate, medium, granular structure in the upper part grading to weak, thin, platy structure in lower part, platy structure is dominant in soil mass below a depth of about 12 inches; granules are slightly hard

when dry, friable when moist; plates are hard when dry, firm when moist; about 15 percent limestone and hard limy shale fragments; moderately alkaline; calcareous; gradual, smooth boundary.

R—15 to 20 inches, pale-yellow (2.5Y 7/4) silty shale; platy; highly calcareous.

The A horizon ranges from 6 to 10 inches in thickness and from dark gray to dark grayish brown in color. Texture is silt loam or heavy silt loam. The AC horizon ranges from 4 to 10 inches in thickness and has a texture of silt loam or light silty clay loam. It is 10 to 15 percent limestone and shale fragments. The underlying shales are in shades of brown, gray, and olive. In some places the underlying shale is interbedded with thin layers of limestone.

Kipson soils are associated with Clime, Tully, and Sogn soils. They are not so deep as Clime soils and are coarser textured than those soils. They are not so deep, are more alkaline in the solum, and are coarser textured than Tully soils. Kipson soils are underlain by shale, and Sogn soils, by limestone.

Kipson-Sogn complex, 3 to 15 percent slopes (Ks).—This complex is 40 percent Kipson silt loam and 20 percent Sogn silty clay loam and rock outcrop. Soils similar to Kipson silt loam, except that the depth to raw shale ranges from 20 to 40 inches, make up 25 percent of the complex; 10 percent is Tully silty clay loam; and 5 percent is Labette silty clay loam. The Sogn soil is associated with and is above the rock outcrop. The Labette soil is above the Sogn soil, and the Kipson and Tully soils are downslope. In places the Sogn soil is on ridgetops, and the Kipson soil is on the sides of the ridges (fig. 13).

Soils of this complex take in water readily if the surface layer has good vegetative cover. The amount of water stored is limited by the shallow depth to limestone or calcareous shale. There is a slight hazard of water erosion, especially where fire has burned off the vegetation or the grass cover is thin. The principal management needs are controlling erosion and maintaining and improving desirable grass species.

These closely intermingled soils are used for range, and are well suited to this use. (Both soils are in capability unit VIe-1; Kipson soil is in Limy Upland range site, and Sogn soil is in Shallow Limy range site; neither soil is in a woodland suitability group; Kipson soil is in windbreak suitability group D, and Sogn soil is in windbreak suitability group G)

Figure 13.—Typical area of Kipson-Sogn complex, 3 to 15 percent slopes. The Sogn soil is on the ridgetops, and the Kipson soil is on the side slopes.

Labette Series

The Labette series consists of well-drained, moderately deep, gently sloping and sloping soils on uplands. These soils formed in residuum over limestone or cherty limestone.

In a representative profile the surface layer is about 8 inches of dark grayish-brown silty clay loam. The subsoil is about 18 inches thick. The upper 6 inches is firm, brown heavy silty clay loam; the lower 12 inches is firm, reddish-brown silty clay. Below the subsoil is cherty limestone.

Labette soils have low to moderate available water capacity and slow permeability.

Representative profile of Labette silty clay loam, 2 to 5 percent slopes, in native grass, 1,400 feet north and 650 feet east of southwest corner of sec. 22, T. 17 S., R. 8 E.:

A1—0 to 8 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) when moist; strong, medium, granular structure; slightly hard when dry, friable when moist; abundant fine roots; slightly acid; gradual, smooth boundary.

B1—8 to 14 inches, brown (7.5YR 4/2) heavy silty clay loam, dark brown (7.5YR 3/2) when moist; moderate, medium, granular structure that has a subangular blocky component; hard when dry, firm when moist; abundant fine roots; shiny surfaces on some peds; slightly acid; gradual, smooth boundary.

B2t—14 to 26 inches, reddish-brown (2.5YR 5/4) silty clay, dark reddish brown (2.5YR 3/4) when moist; peds are coated with brown and dark brown; moderate, medium, blocky structure that has a subangular blocky component in the upper part; very hard when dry, firm when moist; few fine roots; shiny surfaces on most peds; few fine fragments of chert; few black concretions; slightly acid; abrupt, wavy boundary.

R—26 inches, hard cherty limestone.

The A horizon ranges from 6 to 12 inches in thickness. It is dark grayish brown to very dark gray in color. Texture is mostly silty clay loam that contains a small amount of silt loam. Reaction in this horizon is slightly acid to medium acid. The B1 horizon is 4 to 8 inches thick and is brown to grayish brown. The silty clay B2t horizon ranges from 10 to 24 inches in thickness and is dark brown to reddish brown. The B horizon ranges from slightly acid to mildly alkaline. Below the B2t horizon is cherty limestone or limestone. The depth to limestone ranges from 20 to 40 inches.

Labette soils are associated with Florence, Dwight, Sogn, and Irwin soils. They are thinner and have less chert in the B horizon than Florence soils. They are shallower to bedrock than Dwight soils and have a thicker, more granular A horizon. They are deeper to bedrock than Sogn soils and have a clayey B horizon that the Sogn soils do not have. Labette soils are more shallow to bedrock than Irwin soils, have a less abrupt textural boundary between the A and B2t horizons, and are redder in the B2t horizon than Irwin soils.

Labette silty clay loam, 2 to 5 percent slopes (Lb).—This soil generally occurs in narrow bands that are mostly less than 600 feet in width. It has plane and convex slopes. The profile is the one described as representative for the Labette series.

Included with this soil in mapping were minor areas of Dwight and Irwin soils. Also included were areas of soils that have a profile similar to the one described as representative for the Labette series, except that depth to hard limestone is less than 20 inches but more than 15 inches. Together, all of these inclusions make up about 20 percent of the total acreage in the mapping unit. The included Dwight soils are on the same landforms as the Labette soil. The Irwin soils occur where the clayey sedi-

ment is thicker than typical for Labette soils. Other inclusions, all shown on the soil map by symbol, are a few areas of Labette silty clay loam, 2 to 5 percent slopes, eroded, 1 to 4 acres in size, and a few areas of rock outcrop and of a cherty soil, as much as 2 acres in size.

This Labette soil takes in water readily if it is in good tilth. The total amount of water the soil can store is limited by the underlying limestone, but the stored water is readily available for plant use. The major management needs where tilled crops are grown are the control of erosion and maintenance of fertility and good tilth. Runoff is medium to rapid.

Terraces and contour farming help to control water erosion. Good management of crop residue also helps to control erosion and to keep the surface layer in a condition to take in water readily and to work more easily.

About 30 percent of the acreage is cultivated. Wheat and grain sorghum are the main crops. Some crops, such as corn and alfalfa, are affected during dry periods because only a limited volume of water can be stored above the underlying limestone. About 70 percent of the acreage is used as native range. The principal management need where this soil is used for range is maintaining or improving the native grasses. This soil also is suited to tame perennial grasses, trees for windbreaks, and wildlife habitat. (Capability unit IIIe-5; Loamy Upland range site; not in a woodland suitability group; windbreak suitability group C)

Labette-Dwight complex, 1 to 3 percent slopes (Ld).—This complex is in areas above limestone outcrops. On an average, Labette silty clay loam makes up 55 percent of this complex, Dwight silt loam makes up 40 percent, and Irwin silty clay loam inclusions make up 5 percent. In the western part of the county the percentage of Irwin silty clay loam increases to about 20 percent. The Irwin soil is at the higher elevations where the clayey sediment is thicker. Small areas of eroded soils, shown on the map by a symbol, also are included. Each symbol represents an area of about 1 to 4 acres. A symbol also marks the rock outcrops, each symbol representing an area of outcrop up to 2 acres in size. A few sinkholes are shown on the soil map by a symbol.

The Labette soil has low to moderate available water capacity, but the water stored is readily available for plant use. It takes in water readily if the surface layer is in good tilth. The Dwight soil takes in water slowly and releases it slowly to plants. The major management concerns are the control of erosion and the maintenance of fertility and good tilth. Crops grow and mature at an uneven rate because of the differences in soil properties in areas of this complex.

Terraces and contour farming help to control erosion on these soils. Many farmers use a cropping sequence of 3 or 4 years of wheat followed by sweetclover. Growing sweetclover increases the intake of water and helps to maintain fertility and structure of the soil.

About 30 percent of the acreage is used for cultivated crops, mostly wheat and grain sorghum. These soils are not well suited to summer-growing crops, such as alfalfa and corn. About 70 percent of the acreage is used for range. The Labette soil supports tall grasses; the Dwight soil supports mid and short grasses. The principal management needed where the complex is used for range is maintaining or improving the native grasses.

This complex also is suited to tame perennial grasses, trees for windbreaks, and wildlife habitat. (Both soils are in capability unit IIIe-4; Labette soil is in Loamy Upland range site, and Dwight soil is in Claypan range site; neither soil is in a woodland suitability group; Labette soil is in windbreak suitability group C, and Dwight soil is in windbreak suitability group E)

Labette-Sogn complex, 2 to 8 percent slopes (Le).—These soils are on uplands. They occur in narrow bands that average about 400 feet in width. The average area is about 70 percent Labette silty clay loam; 20 percent Sogn soils; and 10 percent included Florence, Kipson, and Dwight soils.

The Labette soil has low to moderate available water capacity but releases water readily for plant use. The Sogn soil has very low available water capacity. Runoff is medium to rapid, depending on slope and the kind of soil.

Soils of this mapping unit are used for range and are better suited to that use than to field crops or tame pasture. The principal management need is maintaining or improving the native grasses. (Both soils are in capability unit VIe-3; Labette soil is in Loamy Upland range site, and Sogn soil is in Shallow Limy range site; neither soil is in a woodland suitability group; Labette soil is in windbreak suitability group C, and Sogn soil is in windbreak suitability group G)

Ladysmith Series

The Ladysmith series consists of deep, moderately well drained and somewhat poorly drained, nearly level and gently sloping soils on uplands. These soils formed in fine-textured sediment that is presumed to be of old alluvial or eolian origin.

In a representative profile the surface layer is about 8 inches of dark-gray silty clay loam. The subsoil is about 43 inches thick. It is very firm, dark-gray silty clay in the upper 27 inches and very firm, light brownish-gray light silty clay in the lower 16 inches. The substratum is light brownish-gray silty clay loam.

Ladysmith soils have high available water capacity and very slow permeability.

Representative profile of Ladysmith silty clay loam, 0 to 2 percent slopes, in native grass, 2,500 feet east and 100 feet south of northwest corner of sec. 7, T. 14 S., R. 7 E.:

A1—0 to 8 inches, dark-gray (10YR 4/1) light silty clay loam, black (10YR 2/1) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist; abundant roots; medium acid; clear, smooth boundary.

B21t—8 to 19 inches, dark-gray (10YR 4/1) silty clay, black (10YR 2/1) when moist; moderate, medium and fine, blocky structure; very hard when dry, very firm when moist; common roots; slightly acid; gradual, smooth boundary.

B22t—19 to 35 inches, dark-gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) when moist; few, fine, faint mottles of yellowish brown (10YR 5/6); moderate, medium, blocky structure; very hard when dry, very firm when moist; few flattened roots; neutral; gradual, smooth boundary.

B3—35 to 51 inches, light brownish-gray (2.5Y 6/2) light silty clay, grayish brown (2.5Y 5/2) when moist; few, fine and medium, distinct mottles of strong brown (7.5YR 5/8); weak, medium, blocky structure; very hard when dry, very firm when moist; few, small, hard concretions of calcium carbonate; moderately alkaline; soil mass is noncalcareous; gradual, smooth boundary.

C—51 to 60 inches, light brownish-gray (10YR 6/2) silty clay loam, grayish brown (10YR 5/2) when moist; many, fine and medium, distinct mottles of reddish yellow (7.5YR 6/8) and strong brown (7.5YR 5/8); massive; very hard when dry, firm when moist; few black specks; moderately alkaline.

The A horizon ranges from 6 to 12 inches in thickness and from dark gray to gray in color. Its texture is mostly light silty clay loam but ranges from heavy silt loam to silty clay loam. Reaction of the A horizon is medium acid or slightly acid. The B horizon ranges from 25 to 50 inches in thickness. The B21t horizon is dark gray or very dark gray, and the B22t horizon is dark gray to grayish brown. Reaction ranges from slightly acid to moderately alkaline. The C horizon is distinctly mottled and ranges from light gray to brownish gray. Reaction ranges from neutral to moderately alkaline.

In Morris County the surface layer of Ladysmith silty clay loam, 1 to 2 percent slopes, eroded, is thinner than the defined range for the series, but this difference does not alter its use or behavior.

Ladysmith soils are associated with Irwin, Smolan, and Dwight soils. They are darker in the B21t horizon than Irwin soils. They have a less abrupt textural change between the A horizon and the B2t horizon than Dwight soils and have a thicker A horizon. Neither do they have a columnar structure in the upper part of the B2t horizon that is characteristic of Dwight soils. Ladysmith soils have a thinner A horizon and a finer textured B horizon than the Smolan soils.

Ladysmith silty clay loam, 0 to 2 percent slopes (Ls).—This soil is mainly on broad upland divides, but a few areas are on old high terraces. Slopes are mainly about 1 percent. This soil has the profile that is described as representative for the series.

Included in mapping were small areas of Irwin and Dwight soils. These are in the lower part of the areas occupied by this Ladysmith soil.

The subsoil releases water slowly for plant use. Runoff is slow and, in a few areas, ponds form for short periods after heavy rains. Management is needed to maintain soil tilth and fertility as well as to increase the intake of water. Erosion is a hazard only on long slopes.

Good management of crop residue helps maintain good tilth and increase the intake of water. Growing deep-rooted legumes also improves the water intake. Terraces can be used, where needed, to help reduce erosion.

Most of the acreage is used for cultivated crops, mainly wheat and grain sorghum. Some alfalfa, corn, and soybeans also are grown. However, corn generally is not grown on this soil, because of summer droughts and the slow release of water by the clayey subsoil.

This Ladysmith soil also is suited to native and tame perennial grasses, trees for windbreaks, and wildlife habitat. (Capability unit IIs–1; Clay Upland range site; not in a woodland suitability group; windbreak suitability group C)

Ladysmith silty clay loam, 1 to 2 percent slopes, eroded (Lt).—This soil is on broad upland divides. In most places the slope is about 2 percent.

In about 60 percent of the acreage, the original surface layer has been thinned by erosion and the present surface layer is heavy silty clay loam about 4 inches thick. In the rest of the acreage the surface layer is mostly silty clay loam, but it is silty clay in a small acreage.

Included with this soil in mapping were small areas of Irwin and Dwight soils. These inclusions occur in the lower parts of areas occupied by this Ladysmith soil.

This soil lacks the good tilth of the less eroded Ladysmith soils. The surface layer crusts rather badly, and in many places a satisfactory stand of a crop is difficult to obtain. The available water capacity is high, but plant growth is restricted because of the slow release of water by the subsoil. Good management is needed to maintain satisfactory soil tilth and fertility as well as to increase the intake of water. Water erosion is the main hazard.

Terraces and contour farming help to control further erosion. Growing deep-rooted legumes improves the intake of water. Good management of crop residue helps reduce further erosion, reduces crusting, increases the intake of water, and aids in maintaining good tilth.

Wheat, grain sorghum, and alfalfa are the main crops. Corn and soybeans generally are not grown on this soil, because of summer droughts and the slow release of water by the clayey subsoil.

Most of the acreage is used for cultivated crops, but the soil also is suited to native grasses, trees for windbreaks, and wildlife habitat. (Capability unit IIIe–3; Claypan range site; not in a woodland suitability group; windbreak suitability group E)

Mason Series

The Mason series consists of deep, well-drained, nearly level soils on low stream terraces. These soils formed in thick, silty alluvial deposits. They are subject to occasional flooding.

In a representative profile the surface layer is about 14 inches of silt loam. The upper 7 inches of this layer is grayish brown and the lower 7 inches is dark grayish brown. The subsoil is about 41 inches thick. It is friable, dark-brown light silty clay loam in the upper 7 inches; firm, brown silty clay loam in the middle 18 inches; and friable, brown light silty clay loam in the lower 16 inches. The substratum is light yellowish-brown light silty clay loam.

Mason soils have high available water capacity and moderately slow permeability.

Representative profile of Mason silt loam in an area of Mason and Reading silt loams, 0 to 1 percent slopes, in a cultivated field, 450 feet north and 400 feet west of southeast corner of sec. 3, T. 17 S., R. 8 E.:

Ap—0 to 7 inches, grayish-brown (10YR 5/2) silt loam, very dark brown (10YR 2/2) when moist; weak, fine and very fine, granular structure; slightly hard when dry, friable when moist; few wormholes and worm casts; slightly acid; abrupt, smooth boundary.

A1—7 to 14 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; moderate, fine and medium, granular structure; slightly hard when dry, friable when moist; many wormholes and worm casts; slightly acid; gradual, smooth boundary.

B1—14 to 21 inches, dark-brown (10YR 4/3) light silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, subangular blocky structure; hard when dry, friable when moist; few wormholes; slightly acid; gradual, smooth boundary.

B2t—21 to 39 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 3/3) when moist; pale brown (10YR 6/3) when crushed dry; moderate, medium,

subangular blocky structure; hard when dry, firm when moist; thin and patchy dark coatings on ped surfaces; few wormholes and worm casts; slightly acid; gradual, smooth boundary.

B3—39 to 55 inches, brown (10YR 5/3) light silty clay loam, dark brown (10YR 3/3) when moist; pale brown (10YR 6/3) when crushed dry; weak, fine, subangular blocky structure; hard when dry, friable when moist; common wormholes; slightly acid; gradual, smooth boundary.

C—55 to 60 inches, light yellowish-brown (10YR 6/4) light silty clay loam, dark yellowish brown (10YR 4/4) when moist; massive; hard when dry, friable when moist; few, fine and medium pores; neutral.

The A horizon ranges from 10 to 15 inches in thickness. Its color ranges from dark gray to grayish brown. Texture ranges from silt loam to light silty clay loam. Reaction is medium acid or slightly acid. The B1 horizon is light silty clay loam or silty clay loam. It ranges from 4 to 10 inches in thickness and from dark gray to grayish brown in color. The B2t and B3 horizons range from 20 to 40 inches in combined thickness and from dark grayish brown to brown. Reaction of the B horizon ranges from medium acid to moderately alkaline. Structure in this horizon is weak to moderate, fine to medium subangular blocky. The C horizon ranges from light yellowish brown to grayish brown and from silty clay loam to silt loam. Reaction ranges from medium acid to moderately alkaline. In places the soil mass is slightly calcareous below a depth of 50 inches.

The average annual temperature of these soils is a few degrees cooler than the minimum defined in the range for the series, but this difference does not alter the usefulness and behavior of the soils.

Mason soils are associated with Reading, Osage, Chase, Smolan, Ivan, and Kennebec soils. They have a coarser textured B horizon than Reading soils and a coarser textured profile than Osage and Chase soils. Mason soils have a B2t horizon, which is lacking in the Ivan and Kennebec soils. They are less red in the lower part of the B horizon than Smolan soils.

In this county Mason soils are mapped only in an undifferentiated group with Reading soils.

Mason and Reading silt loams, 0 to 1 percent slopes (Mr).—Soils of this undifferentiated group are mainly on low terraces along the major streams of the county. These soils are flooded occasionally. About 60 percent of the acreage is Mason silt loam, and about 35 percent is Reading silt loam. The Reading soil is at a slightly higher elevation than the Mason soil, and it is farther from the stream channel.

Included with these soils in mapping were small areas of a Chase silty clay loam and of Ivan and Kennebec silt loams. These inclusions make up about 5 percent of the total acreage. Also included were areas of a Mason silt loam that has short, steep slopes. This included Mason soil makes up less than 1 percent of the total acreage. It is on terrace escarpments between areas of the Mason and Reading soils on low terraces and the areas of included Ivan and Kennebec soils on flood plains adjacent to the stream channel. The included Chase soil is in narrow bands. It is farther from the stream channel than any of the other soils.

The soils in this unit are better suited to crops than any other soils in the county. They are fertile, friable, and easily tilled. They absorb and store water well and release it readily for plant use. Runoff is slow. Maintenance of fertility and tilth is the main management need.

These soils are suited to all crops commonly grown in the county. Wheat, grain sorghum, corn, and alfalfa are the main crops. Any crop that produces sufficient vegetative growth can be grown year after year if the residue is returned to the soil and if weeds and insects are controlled. The return of crop residue helps keep the surface layer in condition to take in water readily and makes it easier to till.

Except for a few small areas, all of these soils are used for crops. The soils also are well suited to tame and native perennial grasses, trees for windbreaks and timber, and wildlife habitat. (Capability unit I–1; Loamy Lowland range site; woodland suitability group 3; windbreak suitability group A)

Osage Series

The Osage series consists of poorly drained, deep, clayey soils on bottom land. These soils are nearly level to concave and occur in areas where sediment has been deposited by backwaters. They are subject to occasional flooding. They formed in clayey alluvium.

In a representative profile the surface layer is about 20 inches of dark-gray light silty clay. The subsoil is very firm, gray silty clay about 40 inches thick.

Osage soils have high available water capacity and very slow permeability.

Representative profile of Osage silty clay, in a cultivated field, 1,300 feet east and 100 feet south of center of sec. 13, T. 17 S., R. 9 E.:

Ap—0 to 6 inches, dark-gray (10YR 4/1) light silty clay, black (10YR 2/1) when moist; weak, fine, blocky structure; very hard when dry, very firm when moist; moderately alkaline; abrupt, smooth boundary.

A1—6 to 20 inches, dark-gray (10YR 4/1) light silty clay, black (10YR 2/1) when moist; moderate, fine and medium, blocky structure; hard when dry, firm when moist; moderately alkaline; diffuse, smooth boundary.

B21g—20 to 38 inches, gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) when moist; few, fine, distinct mottles of yellowish brown (10YR 5/6 and 10YR 5/8); moderate, fine, blocky structure; very hard when dry, very firm when moist; few concretions of calcium carbonate in lower few inches; moderately alkaline; diffuse, smooth boundary.

B22g—38 to 60 inches, gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) when moist; very few very fine mottles of yellowish brown (10YR 5/6); weak, medium, blocky structure; very hard when dry, very firm when moist; few, fine, black concretions; moderately alkaline.

The A horizon ranges from 10 to 25 inches in thickness and from dark gray to very dark gray in color. Its texture ranges from silty clay to heavy silty clay loam. The Bg horizon is dark gray to very dark gray. Reaction of all horizons ranges from slightly acid to moderately alkaline.

The Osage soils are associated with Chase, Mason, and Reading soils. They are more poorly drained than Chase soils and have a finer textured A horizon. They have a finer textured profile than the Mason and Reading soils.

Osage silty clay (0 to 1 percent slopes) (Os).—This nearly level to concave soil occurs in areas where sediment has been deposited by backwater.

Included in mapping were small areas of Chase soils near the perimeter of some areas mapped as this Osage soil.

This soil takes in water slowly and releases it slowly for plant use. Because of very slow runoff, this soil remains wet when there is an excess of moisture. It is slow to warm up in spring, and tillage is often delayed because

of wetness. In dry periods the soil is somewhat droughty, wide cracks form, and tillage is difficult.

A system of open ditches and bedding helps to improve surface drainage. Rough plowing in fall aids in aeration of this soil. Good management of crop residue helps the surface layer absorb more water and prevents soil blowing in spring.

This soil is suited to most crops grown in the county, except for alfalfa and corn. Alfalfa is commonly short lived on this soil. Stands generally thin out or completely disappear within 2 or 3 years. Where an adequate drainage system is installed and maintained, alfalfa can be a dependable crop. Wheat, sorghum, and soybeans are the main crops grown.

All of the acreage is cultivated. The soil also is suited to tame and native perennial grasses, trees grown for windbreaks and timber, and wildlife habitat. (Capability unit IIIw-1; Clay Lowland range site; woodland suitability group 2; windbreak suitability group B)

Reading Series

The Reading series consists of well-drained, deep, nearly level and gently sloping soils on stream terraces. These soils formed in silty and clayey alluvium. The nearly level areas are occasionally flooded.

In a representative profile the surface layer is dark grayish-brown silt loam about 15 inches thick. The subsoil is about 39 inches thick. It is firm, brown silty clay loam in the upper 9 inches; firm, brown heavy silty clay loam in the middle 18 inches; and firm, pale-brown heavy silty clay loam in the lower 12 inches. The substratum is pale-brown light silty clay.

Reading soils have high available water capacity and moderately slow permeability.

Representative profile of Reading silt loam, 1 to 3 percent slopes, in a cultivated field, 400 feet east and 550 feet north of southwest corner of sec. 25, T. 15 S., R. 8 E.:

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; weak, fine and very fine, granular structure; slightly hard when dry, friable when moist; numerous roots; few wormholes; medium acid; abrupt, smooth boundary.

A1—8 to 15 inches, dark grayish-brown (10YR 4/2) heavy silt loam, very dark brown (10YR 2/2) when moist; moderate, fine and medium, granular structure; slightly hard when dry, friable when moist; numerous roots; many wormholes; medium acid; gradual, smooth boundary.

B1—15 to 24 inches, brown (10YR 4/3) silty clay loam, dark brown (10YR 3/3) when moist; many worm granules of dark grayish brown (10YR 4/2); strong, very fine, subangular blocky structure; hard when dry, firm when moist; numerous fine roots; many wormholes and worm casts; medium acid; gradual, smooth boundary.

B2t—24 to 42 inches, brown (10YR 5/3) heavy silty clay loam, dark brown (10YR 3/3) when moist; few, fine, distinct mottles of yellowish brown (10YR 5/6); few black specks in lower part; common dark grayish-brown (10YR 4/2) stains coat the surfaces of peds in the upper 8 inches; moderate, fine and medium, subangular blocky structure that has an angular blocky component; hard when dry, firm when moist; few fine roots; few fine wormholes; medium acid; gradual, smooth boundary.

B3—42 to 54 inches, pale-brown (10YR 6/3) heavy silty clay loam, brown (10YR 4/3) when moist; common, medium, distinct mottles of yellowish brown (10YR 5/6) and a few black specks; weak, fine, blocky structure that has a subangular blocky component; hard when dry, firm when moist; few fine wormholes; few very fine chert fragments in lower part; slightly acid; diffuse, smooth boundary.

C—54 to 60 inches, pale-brown (10YR 6/3) light silty clay, dark brown (10YR 3/3) when moist; few, fine and medium, distinct mottles of yellowish brown (10YR 5/6) and a few black specks; massive; very hard when dry, very firm when moist; common fine and very fine chert fragments; mildly alkaline.

The A horizon ranges from 10 to 20 inches in thickness. Color ranges from dark gray to grayish brown. Texture ranges from silt loam to light silty clay loam. Reaction is medium acid or slightly acid. The B1 horizon is light silty clay loam or silty clay loam. It ranges from 4 to 10 inches in thickness and from brown to grayish brown in color. Reaction is medium acid or slightly acid. The B2t and B3 horizons range from 20 to 40 inches in combined thickness and from brown to pale brown. Reaction is medium acid or slightly acid. The C horizon ranges from pale brown to grayish brown and from silty clay loam to light silty clay. Reaction ranges from slightly acid to moderately alkaline. In some places the soil mass is slightly calcareous below a depth of 50 inches.

Reading soils are associated with Mason, Osage, Chase, Smolan, Ivan, Kennebec, and Tully soils. They have a finer textured B horizon than Mason soils. They have a coarser textured profile than Osage, Chase, and Tully soils. Reading soils have a B2t horizon, which is lacking in the Ivan and Kennebec soils. They are less red in the lower part of the B horizon than Smolan soils.

Reading silt loam, 1 to 3 percent slopes (Rd).—This soil occupies areas immediately above areas of nearly level soils on stream terraces. It has slopes that are plane to slightly convex, and the average slope is 2 percent.

Included with this soil in mapping were small areas of Tully soils. The Tully soils have slightly stronger slopes and are in the higher parts of mapped areas.

This soil is fertile and easy to till. It takes in water readily if the surface layer is kept in good tilth, and it releases water readily for plant use. Surface runoff is medium. The major management needs are the control of erosion and the maintenance of fertility and good tilth.

Terraces and contour farming help control erosion. Good management of crop residue also helps control erosion and keeps the surface layer in condition to take in water readily and to work easily.

This soil is suited to all crops grown in the county. Wheat, grain sorghum, corn, and alfalfa are the main crops.

Most of the acreage is used for crops. The soil also is well suited to tame and native perennial grasses, trees for windbreaks or timber, and wildlife habitat. (Capability unit IIe-1; Loamy Upland range site; woodland suitability group 3; windbreak suitability group A)

Smolan Series

The Smolan series consists of deep, well-drained, gently sloping and sloping soils. These soils are on old, high stream terraces near the stream valleys. They formed in silty material of alluvial and of eolian origin.

In a representative profile the surface layer is about 11 inches thick. The upper 7 inches of this layer is dark grayish-brown silt loam, and the lower 4 inches is dark-brown silty clay loam. The subsoil is about 49 inches thick. The uppermost 7 inches of it is friable, dark-brown silty clay loam; the next 6 inches is firm, dark-brown heavy silty clay loam; the next 8 inches is firm,

reddish-brown heavy silty clay loam; and the lower 28 inches is firm, reddish-brown light silty clay.

Smolan soils have slow permeability and high available water capacity.

Representative profile of Smolan silt loam, 1 to 3 percent slopes, in a cultivated field, 300 feet west and 50 feet south of northeast corner of sec. 32, T. 16 S., R. 9 E.:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; hard when dry, friable when moist; neutral; abrupt, smooth boundary.

A1—7 to 11 inches, dark-brown (7.5YR 4/2) silty clay loam, very dark brown (7.5YR 2/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; slightly acid; clear, smooth boundary.

B1—11 to 18 inches, dark-brown (7.5YR 4/3) silty clay loam, dark brown (7.5YR 3/2) when moist; many ped surfaces coated with dark grayish brown (10YR 4/2); moderate, fine and medium, subangular blocky structure; hard when dry, friable when moist; slightly acid; gradual, smooth boundary.

B21t—18 to 24 inches, dark-brown (7.5YR 4/2) heavy silty clay loam, dark brown (7.5YR 3/2) when moist; many ped surfaces coated with dark grayish brown (10YR 4/2); moderate, fine and medium, blocky structure that has some subangular blocky structure; very hard when dry, firm when moist; medium acid; gradual, smooth boundary.

B22t—24 to 32 inches, reddish-brown (5YR 4/4) heavy silty clay loam, dark reddish brown (5YR 3/4) when moist; dark-brown (7.5YR 4/2) coatings, mostly on vertical surfaces of peds; moderate, medium, blocky structure; very hard when dry, firm when moist; few, fine chert chips; medium acid; gradual, smooth boundary.

B3—32 to 60 inches, reddish-brown (5YR 5/4) light silty clay, reddish brown (5YR 4/4) when moist; darker colored stains on vertical faces of some peds; weak prismatic structure parting to moderate, medium, blocky structure; very hard when dry, firm when moist; medium acid.

The A horizon ranges from 10 to 15 inches in thickness and from silt loam to silty clay loam in texture. The B1 horizon ranges from 4 to 7 inches in thickness. The A and B1 horizons range from dark grayish brown to dark brown in color and from medium acid to neutral in reaction. The combined thickness of the B21t, B22t, and B3 horizons ranges from 30 to 50 inches, and the color ranges from dark brown to reddish brown. Reaction ranges from medium acid to mildly alkaline, and texture ranges from heavy silty clay loam to silty clay. In some places concretions of calcium carbonate are in the B3 horizon.

In Morris County, Smolan silty clay loam, 2 to 6 percent slopes, eroded, is not so dark colored as the defined range for the series, because erosion has removed part or all of the original surface layer.

The Smolan soils are associated with Ladysmith, Irwin, Tully, Mason, and Reading soils. They have a coarser textured B2t horizon and a less abrupt boundary between the A1 and B2t horizons than Ladysmith and Irwin soils. Smolan soils are redder in the lower part of the B horizon than Tully, Mason, and Reading soils.

Smolan silt loam, 1 to 3 percent slopes (Sm).—This soil is on high terraces near streams. Slopes are plane to convex. This soil has the profile described as representative for the series.

Included in mapping were small areas of Tully and Irwin soils, which are in the higher parts of areas mapped as this Smolan soil.

This soil stores a large volume of water, but the subsoil releases it somewhat slowly for plant use. The soil takes in water readily if the surface layer is in good tilth. Surface runoff is medium. The major management needs are the control of erosion and the maintenance of soil fertility and tilth.

Terraces and contour farming help to control erosion on this soil. Good management of crop residue aids in the control of erosion and keeps the surface layer in condition to take in water readily and to work easily.

This soil is suited to all crops grown in the county. Wheat, grain sorghum, soybeans, and alfalfa are the main crops.

This soil is used mainly for crops. It also is well suited to native and tame perennial grasses, trees for windbreaks, and wildlife habitat. (Capability unit IIe-2; Loamy Upland range site; not in a woodland suitability group; windbreak suitability group C)

Smolan silty clay loam, 2 to 6 percent slopes, eroded (Sn).—This soil is on high terraces near present-day streams. The slopes are plane and convex.

The profile of this soil differs from the profile described as representative for the Smolan series in having the original surface layer thinned or removed by erosion on about 80 percent of the acreage. The resulting surface layer is about 7 inches thick and has a silty clay loam texture. The remaining 20 percent of the acreage has a surface layer that is mostly silt loam but, in a few areas, is light silty clay.

Included with this soil in mapping were small areas of Tully and Irwin soils. These included soils occur in the higher parts of the areas mapped as this Smolan soil.

This soil stores a large volume of water, but the subsoil releases it somewhat slowly for plant use. This soil has rapid runoff and is susceptible to severe erosion by water. Management is needed to prevent further erosion, maintain soil tilth and fertility, and increase the intake of water.

Terracing and contour farming help reduce erosion on this soil. Good management of crop residue helps to reduce erosion, increases the intake of water, and aids in maintaining good tilth. Deep-rooted legumes also improve the water intake.

Wheat and grain sorghum are the main crops. Some alfalfa also is grown. Corn generally is not grown, because of summer droughts and the somewhat slow release of water by the clayey subsoil.

Most areas are presently used for cultivated crops, but this soil also is suited to native and tame perennial grasses, trees for windbreaks, and wildlife habitat. (Capability unit IIIe-6; Clay Upland range site; not in a woodland suitability group; windbreak suitability group C)

Sogn Series

The Sogn series consists of somewhat excessively drained, gently sloping and sloping soils on uplands. These soils formed in loamy sediment, and they are shallow over hard limestone.

In a representative profile (fig. 14) the surface layer is very dark gray silty clay loam about 8 inches thick. Below the surface layer is level-bedded, hard limestone that has very few cracks that roots can penetrate.

Sogn soils have moderate permeability and very low available water capacity.

Figure 14.—**Typical profile of a Sogn silty clay loam. This soil is shallow over limestone.**

Representative profile of a Sogn silty clay loam in an area of Labette-Sogn complex, 2 to 8 percent slopes, along road north of Council Grove City Lake, in native grass, 1,400 feet east and 1,640 feet south of center of sec. 31, T. 15 S., R. 8 E.:

A1—0 to 8 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) when moist; moderate, medium, granular structure; hard when dry, friable when moist; few limestone chips in lower part; mildly alkaline; abrupt, smooth boundary.

R—8 inches, level-bedded limestone that has very few crevices or cracks that roots can penetrate.

The A1 horizon ranges from 4 to 15 inches in thickness. It is dark gray to grayish brown and has strong to moderate granular structure. Reaction ranges from neutral to moderately alkaline. The underlying, hard limestone rock is level-bedded and platy or massive. Depth to limestone ranges from 4 to 15 inches.

Sogn soils are associated with Clime, Labette, and Kipson soils. They are more shallow and have a coarser textured profile than Clime soils. They are more shallow than Labette soils and lack the clayey B horizon. Sogn soils are underlain by limestone, whereas Kipson soils are underlain by shale.

Sogn soils are mapped only in complexes with soils of the Clime, Kipson, and Labette series.

Tully Series

The Tully series consists of deep, well-drained, gently sloping to moderately steep soils on uplands. These soils formed in colluvium washed from slopes or in similar sediment.

In a representative profile the surface layer is about 11 inches of dark-gray silty clay loam. The subsoil is about 41 inches thick. The upper 6 inches of the subsoil is firm, dark grayish-brown heavy silty clay loam; the middle 27 inches is firm, brown silty clay; and the lower 8 inches is firm, yellowish-brown silty clay. The substratum is brown light silty clay.

Tully soils have slow permeability and high available water capacity.

Representative profile of Tully silty clay loam, 3 to 7 percent slopes, in native grass, 2,350 feet west and 1,700 feet north of center of sec. 12, T. 17 S., R. 6 E.:

A1—0 to 11 inches, dark-gray (10YR 4/1) silty clay loam, black (10YR 2/1) when moist; moderate, medium and fine, granular structure; slightly hard when dry, friable when moist; abundant roots; slightly acid; clear, smooth boundary.

B1—11 to 17 inches, dark grayish-brown (10YR 4/2) heavy silty clay loam, very dark brown (10YR 2/2) when moist; moderate, fine, subangular blocky structure; hard when dry, firm when moist; many roots; few fine fragments of chert; medium acid; clear, smooth boundary.

B21t—17 to 30 inches, brown (10YR 4/3) silty clay, very dark grayish brown (10YR 3/2) when moist; few very dark gray (10YR 3/1) streaks; moderate, medium and fine, blocky structure; very hard when dry, firm when moist; common fine roots; few fine fragments of chert; shiny surfaces on most peds; medium acid; gradual, smooth boundary.

B22t—30 to 44 inches, brown (10YR 4/3) silty clay, dark brown (10YR 3/3) when moist; common, fine, faint mottles of yellowish brown (10YR 5/6) and a few mottles of strong brown (7.5YR 5/8); moderate, medium, blocky structure parting to weak, fine, blocky structure; very hard when dry, firm when moist; few, fine, black concretions; few fine fragments of chert; slightly acid; gradual, smooth boundary.

B3—44 to 52 inches, yellowish-brown (10YR 5/4) silty clay, dark yellowish brown (10YR 4/4) when moist; common, fine, faint, yellowish brown (10YR 5/8) mottles; few black specks; weak, fine, blocky structure; very hard when dry, firm when moist; few, fine, black concretions; few very fine fragments of chert; neutral; gradual, smooth boundary.

C—52 to 60 inches, brown (7.5YR 5/4) light silty clay, dark brown (7.5YR 4/4) when moist; few, fine, distinct, strong-brown (7.5YR 5/8) mottles in upper 6 inches and common, fine and medium, distinct, strong-brown (7.5YR 5/8) and yellowish-red (5YR 5/6) mottles in lower part; few black specks; massive; very hard when dry, firm when moist; moderately alkaline.

The A1 horizon ranges from 11 to 17 inches in thickness and from heavy silt loam to silty clay loam in texture. The B1 horizon ranges from 4 to 10 inches in thickness. The A1 and B1 horizons range from dark gray to very dark grayish brown and are medium acid to slightly acid. The B21t, B22t, and B3 horizons range from 25 to 48 inches in combined thickness and are grayish brown to yellowish brown. These horizons are medium acid to neutral. In places the B3 horizon is mottled with reddish brown. The C horizon is grayish-brown to reddish-brown heavy silty clay loam to silty clay. Reaction in this horizon ranges from neutral to moderately

alkaline. In places hard calcium carbonate concretions occur at a depth below 30 inches.

In Morris County, Tully silty clay loam, 3 to 7 percent slopes, eroded, has a surface layer thinner than the minimum of the defined range for the series.

Tully soils are associated with Clime, Florence, Irwin, Kipson, Reading, and Smolan soils. Tully soils are deeper, are less alkaline, and have a coarser textured A horizon than Clime soils. They have less chert in the profile than Florence soils. They have a thicker A horizon than Irwin soils and a more gradual textural boundary between the A and B2t horizons. Tully soils are deeper and less alkaline than Kipson soils and have a finer textured profile. They have a finer textured profile than Reading soils. They are less red in the lower part of the B horizon than Smolan soils.

Tully silty clay loam, 3 to 7 percent slopes (Ts).—This soil is mostly below Florence soils and complexes that contain Sogn soils. It has the profile described as representative for the series.

Included in mapping were small areas of Reading and Smolan soils. These included soils occupy the lower parts of areas mapped as this Tully soil. Also included, in the western part of the county, were small areas of soils similar to this soil, except that the depth to free carbonates ranges from 0 to 30 inches and raw shale is at a depth of about 40 inches. Limy areas 1 to 3 acres in size are shown on the map by a symbol. Small eroded areas also are shown by a symbol, and each symbol represents an area of about 1 to 4 acres.

This soil stores a large volume of water but releases it somewhat slowly for plant use. It takes in water readily if the surface layer is in good tilth. The major management needs are the control of erosion and the maintenance of fertility and soil tilth.

Terracing and contour farming help to control erosion on this soil. Good management of crop residue also aids in the control of erosion and helps keep the surface layer in a condition to take in water readily and be worked more easily.

This soil is suited to most crops commonly grown in the county. Corn and soybeans are not so well suited as small grain and sorghums. Wheat, grain sorghum, and alfalfa are the main crops. About 40 percent of the acreage is used for cultivated crops.

About 60 percent of the acreage is native grassland, and the soil is well suited to that use. The principal management need where this soil is used for range is maintaining or improving the native grasses. The soil also is well suited to tame grasses, trees for windbreaks, and wildlife habitat. (Capability unit IIIe-2; Loamy Upland range site; not in a woodland suitability group; windbreak suitability group C)

Tully silty clay loam, 3 to 7 percent slopes, eroded (Tt).—This soil is mainly below Florence soils and complexes that contain Sogn soils.

The profile of this soil differs from the one described as representative for the Tully series in having the original surface layer thinned or removed by erosion on about 70 percent of the acreage. The surface layer is now about 7 inches of heavy silty clay loam. On most of the remaining 30 percent of the acreage, the surface layer is silty clay loam, but in a few places it is silty clay.

Included with this soil in mapping were minor areas of Reading and Smolan soils, both of which are at the lower elevations.

This soil stores a large amount of water but releases it somewhat slowly for plant use. The hazard of water erosion is severe, and runoff is rapid. Management is needed to control erosion, maintain soil tilth and fertility, and increase the intake of water.

Terraces and contour farming help to prevent further erosion on these soils. Good management of crop residue also helps to control erosion, increases the intake of water, and aids in maintaining good tilth. Growing deep-rooted legumes also improves the water intake.

Wheat and grain sorghum are the main crops, and alfalfa also is grown. Corn generally is not grown, because of summer droughts and the somewhat slow release of water by the clayey subsoil.

Most of the acreage is used for crops. This soil also is suited to native and tame perennial grasses, trees for windbreaks, and wildlife habitat. (Capability unit IIIe-6; Clay Upland range site; not in a woodland suitability group; windbreak suitability group C)

Tully soils, 5 to 15 percent slopes (Ty).—The soils in this unit have concave to convex slopes and occur immediately below areas of Florence cherty silt loam, 5 to 15 percent slopes. About 45 percent of the acreage is Tully cherty silty clay loam; 45 percent is Tully silty clay loam; and 10 percent is included areas of Irwin, Clime, Labette, Sogn, and Kipson soils.

The Tully soils have a profile similar to the one described as representative for the series, except that in places the surface layer is cherty silty clay loam that is 10 to 25 percent angular fragments of chert. The subsoil is about 5 to 20 percent angular chert fragments.

Tully soils occupy the smooth side slopes and the concave areas created by small upland drainageways that dissect this mapping unit. The included Clime, Labette, Sogn, and Kipson soils occupy the points of hills and are normally associated with minor areas of limestone outcrop. Included Irwin soils are on side slopes in the lower part of mapped areas.

Most of the soils in this unit have high available water capacity. Runoff is rapid.

These soils are used for range and are better suited to that use than to field crops or tame pasture. The principal management need is maintaining or improving the stand of native grasses. (Capability unit VIe-2; Loamy Upland range site; not in a woodland suitability group; windbreak suitability group C)

Use and Management of the Soils

This section has several main parts. In the first part, management practices needed for soils used for crops are discussed and the system of capability classification used by the Soil Conservation Service is explained. Estimated yields are given for the main crops grown in Morris County. Next, uses of the soils for range, woodland, windbreaks, and wildlife are described. Finally, engineering uses of the soils are described, and soil interpretations for recreational uses are given.

Management of the Soils for Crops [2]

This subsection briefly describes some basic management practices needed for soils used for crops, explains the system of capability classification used by the Soil Conservation Service, and provides a table of predicted average acre yields of the principal crops grown under a high level of management. Those who want detailed information about management of the soils for crops can refer to the section "Descriptions of the Soils." The capability classification of a given soil can be found by referring to the "Guide to Mapping Units" at the back of this survey.

Using and efficiently managing the soils of Morris County for field crops can result in good returns over a period of years without lessening the productivity of the soils. Proper management is using each soil for the crop or purpose for which it is well suited. Good management practices reduce losses of organic matter in cultivated soils. Good management of crop residue is important to the maintenance of good soil structure, the infiltration and percolation of water, and the reduction of erosion. Growing deep-rooted legumes, such as alfalfa and sweetclover, increases the intake of water. Varying the depth of tillage helps to prevent the formation of a plowpan.

To conserve soils used for crops, it is necessary to use a system of management that includes a suitable cropping system, minimum tillage, and optimum use of fertilizer and lime. All available manure and crop residue should be returned to the soil to maintain or improve soil structure and tilth. Terracing, contour farming and constructing necessary waterways help to reduce erosion on sloping soils. Drainage is needed for some soils that are in low areas, and it is needed in a few places for soils on uplands. On most soils good management nearly always consists of a combination of these practices.

Wheat, sorghum, alfalfa, soybeans, and corn are the main crops commonly grown in Morris County. These crops respond well to the use of commercial fertilizer, lime, and manure on most cultivated soils. The kind and amount of fertilizer to use for each crop can best be determined by soil tests, field trials, and observation.

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for forest trees, or for engineering.

In the capability system, the kinds of soil are grouped at three levels—the capability class, the subclass, and the unit. These are discussed in the following paragraphs.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, but not in Morris County, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife habitat, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-2 or IIIe-6. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraphs; and the Arabic numeral specifically identifies the capability unit within each subclass.

In the following paragraphs, the eight capability classes in the system and the subclasses and capability units in Morris County are defined. Suggestions for the use and management of the soils are not given in the descriptions of the capability units but are given under the descriptions of the mapping units in the section "Descriptions of the Soils." The soils in each capability unit can be found by referring to the "Guide to Mapping Units" at the back of this survey.

Class I soils have few limitations that restrict their use (No subclasses)

Unit I-1. Deep, nearly level, well-drained soils that are loamy throughout; on stream terraces.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Subclass IIe. Soils subject to moderate erosion if they are cultivated and not protected.

Unit IIe-1. Deep, gently sloping, well-drained soils that are loamy throughout; on high stream terraces.

[2] EARL J. BONDY, conservation agronomist, Soil Conservation Service, helped prepare this subsection.

Unit IIe-2. Deep, gently sloping, well-drained, loamy soils that are clayey in the lower part of the subsoil; on old, high stream terraces.

Subclass IIw. Soils that have moderate limitations because of excess water.

Unit IIw-1. Deep, nearly level, well-drained soils that are loamy throughout; on flood plains.

Unit IIw-2. Deep, nearly level, moderately well drained, loamy soils that have a clayey subsoil; on stream terraces.

Subclass IIs. Soils that have moderate limitations because they have a subsoil of dense clay.

Unit IIs-1. Deep, nearly level, somewhat poorly drained and moderately well drained or well drained, loamy soils that have a clayey subsoil; on uplands.

Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Subclass IIIe. Soils subject to severe water erosion if they are cultivated and not protected.

Unit IIIe-1. Deep, gently sloping, moderately well drained and well drained, loamy soils that have a clayey subsoil; on uplands.

Unit IIIe-2. Deep, sloping, well-drained, loamy soils that have a clayey subsoil; on uplands.

Unit IIIe-3. Deep, gently sloping, moderately well drained and well drained, eroded, clayey and loamy soils that have a clayey subsoil; on uplands.

Unit IIIe-4. Moderately deep and deep, well drained and moderately well drained, gently sloping, loamy soils that have a clayey subsoil; on uplands.

Unit IIIe-5. Moderately deep, sloping, well-drained, loamy soils that have a clayey subsoil; on uplands.

Unit IIIe-6. Deep, sloping, well-drained, dominantly eroded, loamy soils that have a clayey subsoil; on uplands and on old, high stream terraces.

Subclass IIIw. Soils that have severe limitations because of poor drainage.

Unit IIIw-1. Deep, nearly level, poorly drained soils that are clayey throughout; on bottom lands.

Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.

Subclass IVe. Soils subject to very severe water erosion if they are cultivated and not protected.

Unit IVe-1. Deep, sloping, well-drained, eroded, clayey and loamy soils that have a clayey subsoil; on uplands.

Unit IVe-2. Deep, gently sloping, moderately well drained, loamy soils that have a dense, clayey subsoil; on uplands.

Class V soils are subject to little or no erosion, but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife habitat. (None in Morris County.)

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife habitat.

Subclass VIe. Soils severely limited by poor soil features and by risk of erosion if protective cover is not maintained.

Unit VIe-1. Moderately deep and shallow, gently sloping to moderately steep, moderately well drained to somewhat excessively drained, loamy and clayey soils; on uplands.

Unit VIe-2. Deep and moderately deep, gently sloping to moderately steep, well-drained, cherty and loamy soils that have a clayey subsoil; on uplands.

Unit VIe-3. Moderately deep and shallow, gently sloping and sloping, well-drained and somewhat excessively drained, loamy soils; on uplands. The moderately deep soils have a clayey subsoil.

Subclass VIw. Soils severely limited by excess water and generally unsuitable for cultivation.

Unit VIw-1. Deep, nearly level and gently sloping, well-drained, loamy soils that are frequently flooded; in narrow, meandering upland drainageways.

Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife habitat. (None in Morris County.)

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife habitat, or to esthetic purposes. (None in Morris County.)

Predicted yields

Predicted yields of the main crops grown in Morris County under a high level of management are shown in table 2. The predictions are averages for a period long enough to include both good and bad years. Yields are considerably higher than these averages in years when the temperature and moisture conditions are favorable and are lower in years when temperature and moisture conditions are unfavorable.

Long-time records are not available. Therefore, the yields are predictions only. They were made on the basis of data obtained from farmers, from agricultural technicians, and from the observations of the soil survey party. Soils generally not suited to crops are omitted from table 2. These are Alluvial land and Reading soils (Ar); Clime-Sogn complex, 5 to 20 percent slopes (Cs); Florence cherty silt loam, 5 to 15 percent slopes (Fc); Florence-Labette complex, 2 to 12 percent slopes (Fe); Kipson-Sogn complex, 3 to 15 percent slopes (Ks); Labette-Sogn complex, 2 to 8 percent slopes (Le); and Tully soils, 5 to 15 percent slopes (Ty).

Practices used under a high level of management include: (1) Planting varieties of crops that are adapted to the area; (2) seeding or planting at the proper rate and on the proper date and using efficient methods of planting and harvesting; (3) controlling weeds, insects, and plant diseases to insure normal plant growth; (4) applying at proper times, the kinds and amounts of fertilizer and lime indicated by the results of soil tests; (5)

TABLE 2.—*Predicted average yields per acre of the principal crops grown on arable soils under a high level of management*

[Absence of a yield prediction indicates that the soil is not suited to the crop or that the crop is not commonly grown under a high level of management]

Soil	Corn	Grain sorghum	Wheat	Alfalfa	Sorghum for silage
	Bu.	*Bu.*	*Bu.*	*Tons*	*Tons*
Chase silty clay loam	72	84	45	4.5	25
Dwight silt loam, 1 to 3 percent slopes		36	24	1.4	
Irwin silty clay loam, 0 to 1 percent slopes	46	65	40	3.4	16
Irwin silty clay loam, 1 to 3 percent slopes	44	60	40	3.0	11
Irwin silty clay loam, 3 to 5 percent slopes	40	52	34	2.6	
Irwin soils, 1 to 3 percent slopes, eroded		44	30	2.8	10
Irwin soils, 3 to 5 percent slopes, eroded		42	28	2.2	
Ivan and Kennebec silt loams	62	66			27
Labette silty clay loam, 2 to 5 percent slopes	45	60	35	3.0	13
Labette-Dwight complex, 1 to 3 percent slopes		46	32		
Ladysmith silty clay loam, 0 to 2 percent slopes	45	62	42	3.0	16
Ladysmith silty clay loam, 1 to 2 percent slopes, eroded	40	48	28	2.5	
Mason and Reading silt loams, 0 to 1 percent slopes	86	94	50	5.0	22
Osage silty clay	48	60	36	3.1	15
Reading silt loam, 1 to 3 percent slopes	70	80	45	4.0	20
Smolan silt loam, 1 to 3 percent slopes	62	72	42	3.5	16
Smolan silty clay loam, 2 to 6 percent slopes, eroded		52	30	2.5	10
Tully silty clay loam, 3 to 7 percent slopes	46	70	40	3.0	15
Tully silty clay loam, 3 to 7 percent slopes, eroded		56	30	2.5	10

using such soil and water conserving practices as terraces, grassed waterways, and contour farming; (6) establishing surface drainage where needed; (7) managing crop residue and tilling by using methods designed to control erosion, preserve the soil structure, increase water intake, and favor seedling emergence; and (8) choosing a cropping system that keeps the soil in good condition.

Range Mangement [3]

Rangeland occupies about 260,000 acres, or 57 percent of the total area of Morris County. It is predominant throughout the county except for a major area of cropland running from the north-central part of the county to the southwestern corner. Much of the acreage used for range consists of soils that are too cherty, too rocky, or too steep for cultivation. Most of the range sites are used for grazing by steers or by cows and their calves. Other kinds of livestock use only a minor acreage. A limited acreage is used for hay. Bromegrass, wheat, and sorghum stubble provide additional grazing.

In addition to domestic livestock, a wide variety of wildlife species, such as deer and prairie chicken, are dependent on rangeland for their survival.

Range sites and condition classes

Range consists of soils, not cultivated, on which the natural potential plant community is composed of native grasses, grasslike plants, forbs, and shrubs valuable for grazing use. Rangeland varies in potential productiveness and in the types of plants and proportion of plants that make up the potential plant community. The range potential mainly depends on soil, topography, and climate. For management purposes rangeland is grouped into *range sites.*

[3] By LAWRENCE N. NIEMAN, range conservationist, Soil Conservation Service.

A range site is an area of range uniform enough in climate, soils, drainage, exposure, and topography that it produces a specific kind and amount of vegetation. It differs from other range sites in its potential to produce native plants or in the kinds and proportions of native plants. The differences are great enough to require variations in management. The basic unit on which management of the range is determined is the range site.

Every range site has the potential to support a distinct combination of plants known as *climax vegetation.* Climax vegetation is the most productive combination of range plants that will grow on a site. In most places it is the combination of plants that grew on the site before the range was affected by grazing or cultivation.

Range condition can be rated by comparing the present vegetation on a site with the potential, or climax, vegetation for the site. For management purposes four range condition classes are recognized. They are *excellent*, *good*, *fair*, and *poor*. A range in excellent condition has from 76 to 100 percent of the climax vegetation characteristic of the potential vegetation that was on the site originally; one in good condition has 51 to 75 percent of the climax vegetation; one in fair condition has only 26 to 50 percent of the climax vegetation; and one in poor condition has less than 26 percent of the climax vegetation.

Range plants are either decreasers, increasers, or invaders. If the range is grazed heavily or at the wrong time, the most valuable forage plants on the range, called *decreasers*, become more scarce and eventually disappear. Their place is taken by *increasers*, less palatable plants that make up only a small part of the original vegetation. These increasers, in turn, become less abundant where excessive or untimely grazing is continued, or where fire or insects seriously damage the range. Then, other kinds of plants, called *invaders*, find room to grow. Invaders were not a part of the original vegetation. They are the least desirable plants on the range and are practically worthless.

Descriptions of the range sites

The soils of Morris County have been grouped into seven range sites. The Loamy Upland and Clay Upland range sites make up more than 50 percent of the area in range. Other range sites that make up varying amounts of the acreage are Limy Upland, Claypan, Loamy Lowland, Clay Lowland, and Shallow Limy. The description of each site lists the important soil characteristics, principal plants, and estimated yields of forage. These estimates are for total growth of forage, on a dry-weight basis, where the range is in excellent condition.

The names of soil series represented are mentioned in the description of each range site, but this does not mean that all the soils of a given series are in the range site. Names of all the soils represented in a given range site can be found by referring to the "Guide to Mapping Units" at the back of this survey.

CLAY LOWLAND RANGE SITE

Osage silty clay is the only soil in this range site. This soil is nearly level or concave and occupies areas of backwater sediment. It is deep and poorly drained. When dry, this soil is very hard and large, deep cracks appear in it. This range site receives additional water as the result of flooding and run-in from adjacent slopes.

If this range site is in excellent condition, prairie cordgrass makes up a major part of the vegetation, especially in shallow depressions. The decreasers—big bluestem, indiangrass, switchgrass, and prairie cordgrass—make up more than 80 percent of the total forage where vegetation is in climax condition. Increasers account for about 20 percent. Under prolonged overuse, annual grasses and weed trees become dominant on this site.

The common plants growing on this site are—

Decreasers: Prairie cordgrass, big bluestem, indiangrass, switchgrass, indigobush, eastern gamagrass, Maximilian sunflower, and wholeleaf rosinweed.

Increasers: Sedge, tall dropseed, western wheatgrass, baldwin ironweed, blue grama, western ragweed, wooly verbena, and buckbrush.

Invaders: Osage-orange, elm, Kentucky bluegrass, barnyardgrass, and other annuals.

The average annual yield from this site in excellent condition is approximately 7,500 pounds per acre. Yields range from about 10,000 pounds in favorable years to about 5,000 pounds in unfavorable years.

CLAY UPLAND RANGE SITE

In this site are soils of the Irwin and Ladysmith series and eroded soils of the Smolan and Tully series. Soils in this range site are nearly level to sloping and they are on uplands. They are deep, and the surface layer is silty clay loam. The subsoil is silty clay and silty clay loam that restrict the movement of water and air. Because of high water-retention capacity, these soils are slow to release water to plants during periods of drought.

Decreasers make up 75 percent or more of the total amount of forage where this range site is in excellent condition. Big bluestem, little bluestem, and indiangrass account for most of the yield. Such increaser plants as switchgrass, tall dropseed, and side-oats grama provide most of the rest. Switchgrass reacts as an increaser on this site. If overgrazed it tends to increase at first but, under continued overuse, decreases. Where the range is overgrazed for a long period of time, the cover of plants on this site deteriorates until only annual grasses, tall dropseed, and buckbrush remain.

The common plants growing on this site are—

Decreasers: Big bluestem, little bluestem, indiangrass, prairie-clover, leadplant, and switchgrass.

Increasers: Tall dropseed, side-oats grama, blue grama, western wheatgrass, manyflowered scurfpea, western ragweed, and heath aster.

Invaders: Annual grasses, Kentucky bluegrass, buckbrush, windmillgrass, ironweed, and wooly verbena.

The average total annual yield where this range site is in excellent condition is approximately 4,500 pounds per acre. Yields of air-dry forage range from about 7,000 pounds in favorable years to 2,000 pounds in unfavorable years.

Clay Upland range site is the highest producing upland site in Morris County when moisture conditions are favorable throughout the growing season. Yields are low in dry years. Considerable fluctuation in yields occurs from year to year.

Careful grazing management is needed to maintain maximum productivity of the better forage plants. To match the fluctuation in forage production, the stocking rate must be more varied on this range site than on other range sites.

Vegetation on this site responds fairly readily to improvements in management. Proper location of ponds to help obtain uniform distribution of grazing is difficult in some areas because of the gently sloping relief. Wells, salt, or supplements should be placed in lightly grazed areas when proper distribution of grazing is needed.

CLAYPAN RANGE SITE

In this site are Dwight soils and the eroded soils of the Irwin and Ladysmith series. Soils in this range site are gently sloping and sloping, and they are on uplands. The surface layer ranges from silt loam to silty clay. The subsoil is dense silty clay or clay. The dense subsoil restricts water movement through the soil and releases water slowly to vegetation during periods of drought. These conditions make this a droughty site.

Decreasers make up as much as 60 percent of the total amount of forage in the climax plant community. Increasers account for 40 percent. Generally, side-oats grama, little bluestem, switchgrass, blue grama, and tall dropseed account for most of the yield. Under continued overuse, the plant community eventually consists mostly of annual grasses and annual forbs. Annual three-awn is the dominant species where this site is in poor condition.

The common plants growing on this site are—

Decreasers: Big bluestem, switchgrass, little bluestem, side-oats grama, prairie-clover, and leadplant.

Increasers: Buffalograss, tall dropseed, blue grama, western wheatgrass, manyflowered scurfpea, sedges, western ragweed, and heath aster.

Invaders: Annual bromes, annual three-awn, broomweed, and annual ragweed.

The average annual yield from this site in excellent condition is approximately 2,500 pounds per acre. Yields range from about 3,500 pounds in favorable years to 1,500 pounds in unfavorable years.

Vegetation on the Claypan range site responds slowly to improvements in management. Under grazing this site is seldom in excellent condition. Because it is accessible, livestock tend to keep it overgrazed. Generally, where small areas of this site are associated with loamy upland soils, the overgrazing cannot be avoided. Many acres of former cropland, or "go-back" land, are in this site. Where it is practical to fence these areas, they should be reseeded. If water is available, fences should be maintained after reseeding, and these areas should be managed separately.

LIMY UPLAND RANGE SITE

In this site are silt loams and silty clay soils of the Clime and Kipson series. They are closely intermingled with Sogn soils. The soils in this range site are gently sloping to moderately steep and are on uplands. They are moderately deep and shallow over calcareous shale and are calcareous within 10 inches of the surface. Large amounts of lime in the soil profile and limited soil depth restrict vegetative growth on this site.

Shrub and forb decreasers account for as much as 25 percent of the total climax vegetation. Decreaser grasses—big bluestem, little bluestem, and indiangrass—account for 60 percent or more of the forage. If this site is overgrazed, increaser species replace the decreasers quite rapidly. Under severe overgrazing, vegetation eventually consists of annual broomweed, annual bromes, annual three-awn and brush species.

The common decreasers, increasers, and invader plants that grow on this site are—

Decreasers: Little bluestem, big bluestem, indiangrass, blacksampson, pitcher sage, Jerseytea ceanothus, and prairie-clover.

Increasers: Side-oats grama, hairy grama, Missouri goldenrod, stiff goldenrod, tall dropseed, smooth sumac, and aromatic sumac.

Invaders: Annual bromes, annual three-awn, broomweed, and buckbrush.

The total average annual yield of air-dry forage on this site in excellent condition is approximately 3,500 pounds per acre. Yields range from about 4,500 pounds in favorable years to 2,500 pounds in unfavorable years.

Brush species, such as smooth sumac, aromatic sumac, and buckbrush, become dominant on this site where overgrazing has occurred. Resting, along with chemical control of brush, is necessary to improve these areas. Excessive growth of brush on this site can be prevented through proper grazing and by controlled burning. Generally, brush species are present in small amounts on this site even under good management.

LOAMY LOWLAND RANGE SITE

In this site are Chase, Ivan, Kennebec, Mason, and Reading soils and areas of Alluvial land. These soils are nearly level and are on flood plains and low stream terraces that receive additional water from stream flooding and run-off from adjacent slopes. The soils are deep, and their surface layer ranges from silt loam to silty clay loam. Underlying layers range from silt loam to silty clay. These soils have high available water capacity.

On this range site, decreasers make up 90 percent or more of the climax plant community. Where the site is overgrazed, side-oats grama, tall dropseed, various forbs, and brush species are the major increasers. Weed trees, brush species, annual grass, and annual forbs become dominant under continued overuse.

The common decreasers, increasers, and invader plants on this site are –

Decreasers: Big bluestem, indiangrass, eastern gamagrass, Canada wildrye, compassplant, wholeleaf rosinweed, and switchgrass.

Increasers: Side-oats grama, tall dropseed, blue grama, sedges, ironweed, buckbrush, western ragweed, heath aster, and indigobush.

Invaders: Barnyardgrass, Kentucky bluegrass, annual bromes, annual ragweed, other annuals, Osage-orange, and elm.

The Loamy Lowland range site is the most productive range site in Morris County where it is in good or excellent condition. Where the range is in excellent condition, the total average annual yield of air-dry forage is approximately 8,000 pounds per acre. Yields range from about 6,000 pounds in unfavorable years to 10,000 pounds in favorable years.

This range site is difficult to maintain in excellent condition because of its location. Cattle congregate on this site while moving to and from watering locations and generally keep it overgrazed. Placing salt or other supplements in lightly grazed upland areas is beneficial in drawing cattle off this site. Where overgrazing cannot be prevented, brush control measures may be needed periodically to maintain reasonably good range condition.

LOAMY UPLAND RANGE SITE

In this site are Florence, Labette, Reading, Smolan, and Tully soils. These are deep or moderately deep, gently sloping to moderately steep soils on uplands and high stream terraces (fig. 15). The surface layer is silt loam, cherty silt loam, or silty clay loam; and the subsoil is cherty silty clay loam, cherty clay, silty clay loam, or silty clay. Some soils in this group have stones or chert fragments on the surface as well as in the soil profile.

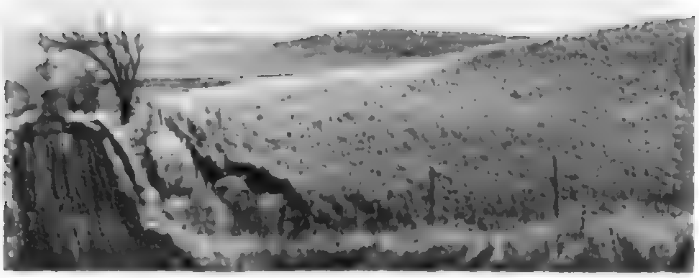

Figure 15.—Area of Loamy Upland range site in excellent condition. The upper side slopes are occupied by Florence cherty silt loam, 5 to 15 percent slopes, and the lower ones, by Tully soils, 5 to 15 percent slopes.

Where the site is in excellent condition, decreaser species make up 85 percent or more of the total forage; big and little bluestem are the dominant species. Side-oats grama, tall dropseed, blue grama, and western ragweed are the major increasers. Under prolonged overgrazing, annual three-awn, annual bromes, and buckbrush make up a large part of the plant community.

The common decreasers, increasers, and invader plants that grow on this site are—

Decreasers: Little bluestem, big bluestem, indiangrass, switchgrass, prairie-clover, leadplant, Jerseytea ceanothus, and pitcher sage.

Increasers: Side-oats grama, blue grama, tall dropseed, western ragweed, heath aster, stiff goldenrod, and smooth sumac.

Invaders: Annual three-awn, annual bromes, buckbrush, annual broomweed, and Kentucky bluegrass.

Total average annual yield on this site in excellent condition is approximately 5,000 pounds per acre, but it ranges from about 6,500 pounds in favorable years to 3,500 pounds in unfavorable years.

Average yield on this site compares closely to the average yield on the Clay Upland range site, but fluctuations are not so great on the Loamy Upland range site. Occasional controlled burning is needed for brush control, and it is helpful in obtaining uniform distribution of grazing. Vegetation on this range site responds quickly to improvements in management, especially in favorable years.

SHALLOW LIMY RANGE SITE

Only Sogn soils are in this range site. These are gently sloping and sloping soils on uplands. They are in narrow bands adjacent to soils of the Limy Upland or Loamy Upland range sites. The soils range from 4 to 15 inches deep over beds of platy or massive limestone. The limestone beds restrict the amount of water available for plant use and inhibit normal vegetative root development. As a result, the yield of forage is low on this site.

In the climax plant community, little bluestem, side-oats grama, and decreaser forbs generally account for 60 percent or more of the total yield. Increasers make up the rest. When overgrazing occurs, blue grama, hairy grama, and buffalograss replace the more desirable plants. Annual bromes, annual three-awn, and annual broomweed make up a large part of the plant community if continued overgrazing is allowed.

The common decreasers, increasers, and invader plants that grow on this site are—

Decreasers: Big bluestem, little bluestem, switchgrass, prairie-clover, blacksampson, and Jerseytea ceanothus.

Increasers: Side-oats grama, blue grama, hairy grama, and buffalograss.

Invaders: Broomweed, annual bromes, and annual three-awn.

Total average annual yield of air-dry forage from this site in excellent condition is approximately 2,500 pounds per acre. Production ranges from about 1,500 pounds per acre in unfavorable years to 3,500 pounds per acre in favorable years.

This range site generally makes up only a small percentage of the total acreage of any area of range in Morris County. It is generally in poorer condition than surrounding sites. So long as the surrounding sites are properly managed, it is economically impractical to adjust management to improve this site or to maintain it in excellent condition.

Use of the Soils for Woodland and Windbreaks [4]

In this subsection the soils of Morris County are discussed on the basis of their suitability as woodland and for windbreaks. Soils suitable for use as woodland are placed in three woodland suitability groups, the soil-related hazards and limitations are rated, and the suitable tree species are listed for each group. Soils suitable for trees and shrubs that are used for farmstead windbreaks are placed in windbreak suitability groups of soils.

The names of soil series represented are mentioned in the description of each woodland suitability group or windbreak suitability group, but this does not mean that all the soils of a given series are in the group. Also, not all the soils in the county have been placed in these groups. To determine whether a given soil has been placed in one of these groups, and to find which group, refer to the "Guide to Mapping Units" at the back of this survey.

Native woodland

About 8,700 acres of woodland is in Morris County. This acreage is mostly in narrow bands and in small areas along stream valleys.

Many of these areas would produce good sawtimber if they were properly managed. Good management practices protect the trees from fire and grazing and clear the areas of cull trees and wolf trees.

Management of woodland can be planned more effectively if the soils are grouped so that those on which similar kinds of wood crops are produced, that require similar management for these crops, and that have about the same potential productivity for wood crops are placed in one group. In Morris County only the soils that receive additional water as the result of stream flooding or that receive extra water from runoff are considered capable of producing merchantable wood products, and they are the only soils placed in woodland suitability groups.

For the soils of each group, potential productivity for wood crops is expressed as the site index, which is the height attained by the average dominant and codominant trees at the age of 50 years. The site index reflects average productivity of all the soils in a suitability group.

The management concerns discussed for each woodland suitability group are seedling mortality, plant competition, equipment limitations, windthrow hazard, and erosion hazard.

Seedling mortality refers to the expected loss of seedlings caused by unfavorable soil characteristics and topographic features, excluding losses caused by plant competition. Mortality is *slight* if not more than 25 percent of seedlings die or if trees regenerate naturally. It is *moderate* if 25 to 50 percent of seedlings die, or if

[4] Prepared with the assistance of F. D. ABBOTT, State resource conservationist, Soil Conservation Service.

trees do not regenerate naturally in numbers sufficient to restock the site. It is *severe* if more than 50 percent of seedlings die, or if trees do not ordinarily reseed naturally where there are enough seeds.

Plant competition refers to invasion by undesirable species of trees or brush, which compete with desirable species for moisture and plant nutrients. It is *slight* if invader plants do not prevent natural regeneration or the growth of seedlings. It is *moderate* if invaders delay, but do not prevent, the establishment of a fully stocked stand. It is *severe* if invader plants prevent adequate natural regeneration, without intensive preparation of the site and without special maintenance practices.

The use of equipment is limited by wetness, stoniness, slope, and lack of moisture. Some limitations are seasonal; others occur throughout the year. The limitation is *slight* if there is little or no restriction on the type of equipment or the time of year that it can be used. It is *moderate* if the use of equipment is limited by slope or seasonal wetness. It is *severe* if the use of equipment is limited by slope, rocks, texture, instability of the soils, or seasonal wetness.

Windthrow hazard refers to the resistance of trees to strong winds. It is determined by root depth and the protection provided by surrounding trees. Windthrow hazard is *slight* if roots normally hold the trees firmly against a wind, and if individual trees remain standing where surrounding trees are removed. It is *moderate* if roots hold the trees firmly except when the soil is excessively wet and the wind velocity is exceptionally high. It is *severe* if roots are not deep enough to stabilize the trees unless they are protected by other trees.

Erosion hazard is rated according to expected erosion that is a result of the cutting and removal of trees. The hazard is *slight* if potential erosion is unimportant; *moderate* if some practices, such as those for diverting water, are needed to prevent accelerated erosion; and *severe* if intensive treatment is needed to control soil losses.

WOODLAND SUITABILITY GROUP 1

In this group are Ivan, Kennebec, and Reading soils and the land type Alluvial land. These are deep, well-drained soils on bottom lands that are frequently flooded for short periods. Permeability is moderate to moderately slow.

The soils in this group are highly productive (fig. 16). The site index ranges from 50 to 80 for mixed hardwoods. It is 60 to 75 for black walnut, hackberry, and

Figure 16.—An excellent stand of walnut trees and oaks on Ivan and Kennebec silt loams.

green ash; 50 to 60 for bur oak; and 65 to 80 for soft maple. These soils can be expected to produce 170 to 230 board feet per acre per year of black walnut, hackberry, green ash, or soft maple and 100 to 140 board feet of bur oak.

Seedling mortality is moderate because of flooding in spring. The loss of seedlings from drought is slight. Plant competition to young, desirable trees is severe. Vines and weed trees hinder the growth of desirable species, and competition from this source needs to be reduced.

Equipment limitations are slight. Only flooding will prevent operation of logging and other equipment. The windthrow hazard is slight, and no special precautions are necessary. The erosion hazard is slight. Clean cutting near or in old or existing stream channels should be avoided to prevent bank erosion.

WOODLAND SUITABILITY GROUP 2

Osage silty clay is the only soil in this group. It is a deep, poorly drained, nearly level to concave soil in areas of backwater sediment. This soil is subject to occasional flooding. Permeability is very slow.

This soil produces fair tree growth. The site index for mixed hardwood species ranges from about 50 to 60. This soil can be expected to produce 100 to 140 board feet per acre per year of green ash, soft maple, or American elm.

Seedling mortality is moderate because of spring flooding and wetness. Loss of seedlings from drought in dry summers is common. Plant competition is severe because desirable species must compete with grass, weed trees, and vines.

Equipment limitations are severe. Operation of equipment causes soil compaction and injury to roots, except during the driest months. The windthrow hazard is severe. The stands of trees need to be opened slowly so that single trees are not left unprotected. The erosion hazard is only slight, but deposition is common.

WOODLAND SUITABILITY GROUP 3

In this group are Chase, Mason, and Reading soils. These are deep, nearly level, moderately well drained and well drained soils on stream terraces. They are occasionally flooded. Permeability is moderately slow to slow.

The soils of this group are highly productive. The site index ranges from about 65 to 75 for bur oak, green ash, and hackberry. The rating for black walnut is 60 to 75. These soils can be expected to produce 170 to 230 board feet per acre per year of black walnut, green ash, and hackberry and 100 to 140 board feet of bur oak.

Seedling mortality is slight. Soil conditions are favorable for seedling survival and growth. Plant competition is moderate. Treatment is needed to remove competing vines and weed trees.

Equipment limitations are slight. Only the slight flooding limits the operation of equipment. The windthrow hazard is slight. The erosion hazard is slight.

Farmstead windbreaks

Farmsteads exposed to cold winds in winter and hot winds in summer need the protection of windbreaks. Also, many feedlots in the county need the protection of a windbreak. Trees and shrubs for windbreaks should be selected according to their suitability for the soils. Many sites that are considered unsuitable for use as woodland can be planted to windbreaks. All of the soils in Morris County are suited to trees grown for windbreaks if the proper species is selected (fig. 17).

The soils of Morris County are placed in seven windbreak suitability groups. These are described in the paragraphs that follow.

WINDBREAK SUITABILITY GROUP A

In this group are Chase, Ivan, Kennebec, Mason, and Reading soils and the land type Alluvial land. These soils are deep, well drained and moderately well drained, and nearly level. They are on flood plains and stream terraces. Permeability is moderate to slow. The soils are occasionally to frequently flooded. Root penetration is good, and the soils are suited to most trees that grow in the county. Trees and shrubs suitable for planting in windbreaks are—

Conifers: Austrian pine, shortleaf pine, Scotch pine, and eastern redcedar.

Tall broadleaf trees, fast growers: Siberian elm, cottonwood, silver maple, and sycamore.

Tall broadleaf trees, slow to moderate growers: Black walnut, bur oak, green ash, hackberry, honeylocust, and pin oak.

Intermediate-height broadleaf trees: Osage-orange, Russian mulberry, and Russian-olive.

Shrubs: Bush-honeysuckle, lilac, multiflora rose, and American plum.

WINDBREAK SUITABILITY GROUP B

Osage silty clay is the only soil in this group. It is a deep, poorly drained, nearly level to concave soil in areas of backwater sediment. This soil has very slow permeability and is subject to occasional flooding. The site is soggy and wet for extended periods, and in dry periods it forms cracks. Trees and shrubs suitable for planting are—

Conifers: Austrian pine, eastern redcedar, and shortleaf pine.

Tall broadleaf trees, fast growers: Cottonwood, silver maple, and sycamore.

Tall broadleaf trees, slow to moderate growers: Bur oak, green ash, hackberry, honeylocust, and pine oak.

Intermediate-height broadleaf trees: Osage-orange, Russian mulberry, and Russian-olive.

Shrubs: Bush-honeysuckle, lilac, multiflora rose, and American plum.

WINDBREAK SUITABILITY GROUP C

In this group are Irwin, Labette, Ladysmith, Smolan, and Tully soils. These soils are deep and moderately deep, are well drained and moderately well drained to somewhat poorly drained, and are on uplands. Permeability is slow or very slow. Root penetration and moisture available for plant growth are fair to good. Trees and shrubs suitable for windbreaks are—

Conifers: Austrian pine, shortleaf pine, Scotch pine, and eastern redcedar.

Tall broadleaf trees, fast growers: Siberian elm, cottonwood, silver maple, and sycamore.

Figure 17.—Farmstead windbreak on Irwin silty clay loam, 1 to 3 percent slopes. This windbreak protects the farmstead and the corrals from winds in winter.

Tall broadleaf trees, slow to moderate growers: Bur oak, green ash, hackberry, honeylocust, and pin oak.
Intermediate-height broadleaf trees: Osage-orange, Russian mulberry, and Russian-olive.
Shrubs: Fragrant sumac, gray dogwood, bush-honeysuckle, lilac, multiflora rose, and American plum.

WINDBREAK SUITABILITY GROUP D

In this group are Clime and Kipson soils. These moderately deep and shallow, moderately well drained or well drained soils are on uplands. Permeability is moderate and moderately slow. Root penetration and moisture available for plant growth are only fair. Trees and shrubs suitable for planting are—

Conifers: Austrian pine and eastern redcedar.
Tall broadleaf trees, slow to moderate growers: Bur oak, green ash, hackberry, honeylocust, and Siberian elm.
Intermediate-height broadleaf trees: Osage-orange, Russian mulberry, and Russian-olive.
Shrubs: Bush-honeysuckle, lilac, multiflora rose, American plum, fragrant sumac, and gray dogwood.

WINDBREAK SUITABILITY GROUP E

In this group are Dwight, Irwin, and Ladysmith soils. These deep, moderately well drained to well drained soils are on uplands. Permeability is very slow. Root penetration is fair to poor. Soils in this group are subject to damaging drought in dry periods. Trees and shrubs suitable for planting are—

Conifers: Eastern redcedar.
Tall broadleaf trees, slow to moderate growers: Pin oak.
Intermediate-height broadleaf trees: Osage-orange.
Shrubs: Fragrant sumac.

WINDBREAK SUITABILITY GROUP F

In this group are soils of the Florence series. They are deep, well-drained soils on uplands. Permeability is moderately slow. Root penetration and moisture available for plant growth are fair. Trees and shrubs suitable for planting are—

Conifers: Eastern redcedar, Austrian pine, and Scotch pine.
Tall broadleaf trees, slow to moderate growers: Bur oak and honeylocust.
Intermediate-height broadleaf trees: Osage-orange.
Shrubs: Fragrant sumac, gray dogwood, and American plum.

WINDBREAK SUITABILITY GROUP G

In this group are soils of the Sogn series, which occur only in complexes with Clime, Kipson, and Labette soils. They are shallow, somewhat excessively drained soils on

uplands. Permeability is moderate. Root penetration and moisture available for plant growth are poor. Trees and shrubs suitable for planting are—

Conifers: Eastern redcedar.
Intermediate-height broadleaf trees: Osage-orange.
Shrubs: Fragrant sumac and gray dogwood.

Use of the Soils for Wildlife [5]

The wildlife population of any area depends upon the availability of food, cover, and water in a suitable combination. The lack of any of these requirements, an unfavorable balance between them, or an inadequate distribution of them can seriously limit or make impossible the use of a tract as a habitat for desired species of wildlife. Most wildlife habitats are created, improved, or maintained by establishing and manipulating vegetation, and by providing food and water in suitable places. Information about the soils is essential in carrying out these measures. Such information is also useful in broadscale planning for parks, nature areas, or other recreational development having wildlife management aspects.

A convenient way to discuss wildlife in Morris County is by soil associations. The soil associations and the soils in them are described in the section "General Soil Map." The location of each soil association is shown on the general soil map at the back of this survey.

Table 3 rates the potential of each of the five soil associations in the county for producing available habitat for various kinds of wildlife and fish.

The classes of wildlife are described as follows:

Upland wildlife consists of birds and mammals that normally frequent croplands, pastures, meadows, lawns, and areas overgrown with grasses, herbs, and shrubby vegetation. Examples of this kind of wildlife are quail, pheasant, meadowlarks, field sparrows, redwinged blackbirds, cottontail rabbit, red fox, and marmots.

Woodland wildlife consists of birds and mammals that normally live in wooded areas composed of hardwood trees and shrubs, coniferous trees and shrubs, or mixtures of these plants. Examples of this kind of wildlife are thrushes, vireos, grey and fox squirrels, red fox, white-tailed and mule deer, raccoon, and turkey.

Wetland wildlife consists of birds and mammals that normally frequent such wet areas as ponds, streams or ditches, marshes, and swamps. Examples of this kind of wildlife are wood ducks, mallards, pintails, rails, herons, other kinds of shore birds, mink, muskrat, and beaver.

The bobwhite quail is the most important game bird in the county. These birds reach their greatest populations in the Mason-Tully-Reading and the Chase-Mason-Reading soil associations. Scattered numbers are in the rest of the soil associations where woody cover is available.

Kansas has one of the largest populations of prairie chicken in the nation. Extensive areas of native grass interspersed with cultivated fields provide ideal habitat. In Morris County the Labette-Florence and Irwin-Ladysmith soil associations support grassland vegetation that is essential to a satisfactory population of prairie chicken.

The mourning dove is a migratory game bird that nests in suitable locations throughout the county. Especially important in management of this species is the availability of water and seed foods. Habitat is most favorable in the Labette-Florence and the Irwin-Ladysmith soil associations.

Many species of song and insectivorous birds, such as meadowlark, brown thrasher, cardinal, robin, woodpeckers, and wrens, nest in or migrate through the

[5] By JACK WALSTROM, biologist, Soil Conservation Service.

TABLE 3.—*Potential of soil associations for providing habitat elements for stated classes of wildlife and fish*

[Dashes in columns indicate habitat element not applicable to class of wildlife or to fish]

Soil association	Class of wildlife	Habitat elements			
		Woody cover	Herbaceous cover	Aquatic cover	Food
1. Labette-Florence.	Upland	Good	Excellent	Good	Good.
	Woodland	Good	Good	Good	Good.
	Wetland	Fair	Fair	Good	Good.
	Fish	---	---	Good	Good.
2. Irwin-Ladysmith.	Upland	Good	Good	Good	Good.
	Woodland	Good	Good	Good	Good.
	Wetland	Good	Good	Good	Good.
	Fish	---	---	Good	Good.
3. Chase-Mason-Reading.	Upland	Excellent	Excellent	Excellent	Excellent.
	Woodland	Excellent	Excellent	Excellent	Excellent.
	Wetland	Excellent	Excellent	Excellent	Excellent.
	Fish	---	---	Excellent	Excellent.
4. Mason-Tully-Reading.	Upland	Excellent	Excellent	Excellent	Excellent.
	Woodland	Excellent	Excellent	Excellent	Excellent.
	Wetland	Excellent	Excellent	Excellent	Excellent.
	Fish	---	---	Excellent	Excellent.
5. Irwin-Kipson-Sogn.	Upland	Good	Good	Good	Good.
	Woodland	Good	Good	Good	Good.
	Wetland	Good	Good	Good	Good.
	Fish	---	---	Good	Good.

county. Several species of hawks and owls also are common residents.

Other species of upland wildlife are badger, coyote, fox, squirrel, rabbit, and skunk. These animals occupy favorable habitat in all soil associations.

Deer are increasing in numbers throughout the county. Two species—mule and white-tailed—are in the county, but the white-tailed deer is the more numerous. The Mason-Tully-Reading and the Chase-Mason-Reading soil associations provide the most desirable habitat for deer.

The Rio Grande turkey has been released in Chase County near the southern boundary of Morris County. It is expected that these birds will increase and occupy favorable woodland habitat within the county.

The construction of Council Grove Reservoir on the Neosho River, north of Council Grove, has increased the habitat for waterfowl. Council Grove Lake and Lake Kahola also are used by waterfowl during the semiannual migrations. Soils inundated by these reservoirs are primarily in the Mason-Tully-Reading soil association.

Beaver, muskrat, mink, raccoon, and shorebirds are mainly in the wetlands of the Mason-Tully-Reading and the Chase-Mason-Reading soil associations. Water areas in other soil associations also provide desirable habitat.

Fishing ranges from good to excellent in the many farm ponds, reservoirs, and streams throughout the county. Bass, bluegills, channel catfish, bullheads, crappie, and yellow catfish are the primary species of game fish. Northern pike and walleyed pike in Council Grove Reservoir provide additional incentive to fishermen.

Further information and assistance in planning and developing wildlife habitat can be obtained at the local office of the Soil Conservation Service; from the Kansas Forestry, Fish, and Game Commission; from the Bureau of Sport Fisheries and Wildlife; and from the county extension agent.

Engineering Uses of the Soils [6]

This section is useful to those who need information about soils used as structural material or as foundation upon which structures are built. Among those who can benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Among properties of soils highly important in engineering are permeability, strength, compaction characteristics, soil drainage condition, shrink-swell potential, grain size, plasticity, and soil reaction. Also important are depth to the water table, depth to bedrock, and soil slope. These properties, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.

[6] FRANKLIN C. KINSEY, civil engineer, Soil Conservation Service, helped to prepare this section.

TABLE 4.—*Estimated soil properties*

[An asterisk in the first column indicates that at least one mapping unit in the series is made up of two or more kinds of soil that may differ means more than; the

Soil series and map symbols	Depth to bedrock	Depth from surface (typical profile)	Classification: USDA texture	Classification: Unified	Classification: AASHO
	Feet	*Inches*			
Alluvial land and Reading soils: Ar. Properties too variable for valid estimates.					
Chase: Ch	>5	0–20	Silty clay loam	CL	A-7
		20–44	Silty clay	CH	A-7
		44–60	Heavy silty clay loam	CH or CL	A-7
*Clime: Cs. For properties of the Sogn soil, refer to the Sogn series.	2–3½	0–30	Silty clay	CL or CH	A-7
		30	Clayey shale.		
Dwight: Dh	3½–5	0–5	Silt loam	ML or ML-CL	A-4 or A-6
		5–52	Clay or silty clay	CH	A-7
		52	Cherty limestone.		
*Florence: Fc, Fe. For properties of Labette soils in Fe, refer to the Labette series.	3½–5	0–4	Cherty silt loam	ML or CL	A-4 or A-6
		4–15	Cherty silty clay loam	GM, GC, ML, or CL	A-2 or A-6
		15–44	Cherty clay	GC or CH	A-2 or A-7
		44	Cherty limestone.		

See footnote at end of table.

4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the soils on which they are built, for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 4 and 5, which show, respectively, several estimated soil properties significant to engineering and interpretations for various engineering uses.

This information, along with the soil map and other parts of this publication, can be used to make interpretations in addition to those given in tables 4 and 5, and it also can be used to make other useful maps.

This information, however, does not eliminate need for further investigations at sites selected for engineering works, especially works that involve heavy loads or that require excavations to depths greater than those shown in the tables, generally depths greater than 5 feet. Also, inspection of sites, especially the small ones, is needed because many delineated areas of a given soil mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this soil survey have special meaning to soil scientists. These terms and others are defined in the Glossary according to their meaning in soil science.

Engineering classification systems

The two systems most commonly used in classifying samples of soils for engineering are the AASHO system adopted by the American Association of State Highway Officials, and the Unified system used by the SCS engineers, Department of Defense, and others. The explanation of these systems in the following paragraphs is taken largely from the PCA Soil Primer (*7*).

The AASHO system is used to classify soils according to those properties that affect use in highway construction (*1*). In this system a soil is placed in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A-1 are gravelly soils of high bearing strength, and, at the other extreme, clay soils that have low strength when wet. The best soils for subgrade foundation are therefore classified as A-1, the next best A-2, and so on to class A-7, the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A-1, A-2, and A-7 groups are divided as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6. If soil material is near a classification boundary, it is given a symbol showing both classes; for example, A-2 or A-6. As additional refinement, the relative engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 for the poorest. The estimated classification for all soils mapped in Morris County is given in table 4.

significant in engineering

in properties. For this reason the reader should follow carefully the instructions for referring to another series in this column. The sign > sign < means less than]

Percentage of material less than 3 inches in diameter passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)				
				Inches per hour	*Inches per inch of soil*	*pH value*	
100	100	95–100	90–100	0.20–0.63	0.17–0.19	5.6–7.0	Moderate.
100	100	95–100	90–100	0.06–0.20	0.17–0.19	5.6–7.3	High.
100	100	95–100	90–100	0.20–0.63	0.17–0.19	6.1–7.8	High.
95–100	95–100	85–95	80–95	0.20–0.63	0.17–0.19	7.4–8.0	Moderate.
100	100	95–100	95–100	0.20–0.63	0.16–0.18	5.6–7.0	Low.
100	100	95–100	95–100	$<$0.06	0.17–0.19	6.1–8.0	High.
[1] 60–100	60–94	60–90	56–86	0.20–0.63	0.14–0.16	6.1–7.3	Moderate.
20–80	16–76	16–70	16–66	0.20–0.63	0.06–0.08	6.1–7.3	Low.
20–75	16–70	16–70	16–66	0.20–0.63	0.04–0.06	6.1–7.3	Low.

TABLE 4.—*Estimated soil properties*

Soil series and map symbols	Depth to bedrock	Depth from surface (typical profile)	Classification		
			USDA texture	Unified	AASHO
	Feet	*Inches*			
Irwin:					
Ic, Id, Ie	>3½	0–10	Silty clay loam	CL	A-6
		10–60	Silty clay	CH	A-7
In, Io	>3½	0–5	Silty clay	CH	A-7
		5–60	Silty clay	CH	A-7
*Ivan: Iv For properties of the Kennebec soils, refer to the Kennebec series.	>5	0–60	Silt loam	CL or ML-CL	A-6
Kennebec Mapped only with soils of the Ivan series.	>5	0–60	Silt loam	CL or ML-CL	A-6
*Kipson: Ks For properties of the Sogn soils, refer to the Sogn series.	1–1½	0–15	Silt loam	ML-CL or CL	A-4 or A-6
		15	Shale.		
*Labette: Lb, Ld, Le For properties of the Dwight soils in Ld, and of the Sogn soil in Le, refer to their respective series.	1½–3½	0–14	Silty clay loam	ML-CL or CL	A-6 or A-7
		14–26	Silty clay	CH	A-7
		26	Cherty limestone.		
Ladysmith:					
Ls	>5	0–8	Silty clay loam	CL	A-6
		8–51	Silty clay	CH	A-7
		51–60	Silty clay loam	CL or CH	A-7
Lt	>5	0–4	Heavy silty clay loam	CH	A-7
		4–51	Silty clay	CH	A-7
		51–60	Silty clay loam	CL or CH	A-7
*Mason: Mr For properties of the Reading soil, refer to the Reading series.	>5	0–14	Silt loam	ML-CL or CL	A-4 or A-6
		14–60	Silty clay loam	CL	A-6 or A-7
Osage: Os	>5	0–60	Silty clay	CH	A-7
Reading: Rd	>5	0–15	Silt loam	CL	A-6
		15–54	Silty clay loam	CH or CL	A-7
		54–60	Light silty clay	CH	A-7
Smolan:					
Sm	>5	0–7	Silt loam	CL or ML-CL	A-6
		7–18	Silty clay loam	CL	A-6 or A-7
		18–32	Heavy silty clay loam	CL or CH	A-7
		32–60	Light silty clay	CH	A-7
Sn	>5	0–32	Silty clay loam	CH or CL	A-6 or A-7
		32–60	Light silty clay	CH	A-7
Sogn Mapped only in complexes with Clime, Kipson, and Labette soils.	½–1½	0–8	Silty clay loam	CL	A-6 or A-7
		8	Limestone.		
Tully:					
Ts	>4	0–17	Silty clay loam	CL	A-6
		17–60	Silty clay	CH	A-7
Tt	>4	0–7	Heavy silty clay loam	CL or CH	A-7
		7–60	Silty clay	CH	A-7
Ty. Properties too variable for valid estimates.					

[1] Fragments larger than 3 inches in diameter are estimated to be 0 to 40 percent in the 0- to 4-inch layer and 0 to 75 percent in the lower two layers.

significant in engineering—Continued

Percentage of material less than 3 inches in diameter passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)				
				Inches per hour	*Inches per inch of soil*	*pH value*	
95-100	95-100	90-100	90-100	0. 20-0. 63	0. 17-0. 19	5. 6-7. 3	Moderate.
95-100	95-100	95-100	90-100	<0. 06	0. 17-0. 19	5. 6-7. 8	High.
95-100	95-100	95-100	90-100	0. 06-0. 20	0. 17-0. 19	5. 6-7. 3	High.
95-100	95-100	95-100	90-100	<0. 06	0. 17-0. 19	5. 6-7. 8	High.
100	100	95-100	90-100	0. 63-2. 00	0. 17-0. 19	7. 4-8. 4	Moderate.
100	100	95-100	90-100	0. 63-2. 00	0. 17-0. 19	5. 6-8. 0	Moderate.
85-95	80-90	80-90	80-90	0. 63-2. 00	0. 17-0. 19	7. 4-8. 4	Low.
100	100	95-100	95-100	0. 20-0. 63	0. 17-0. 19	5. 6-6. 5	Moderate.
100	100	95-100	95-100	0. 06-0. 20	0. 17-0. 19	6. 1-7. 8	High.
100	100	95-100	95-100	0. 20-0. 63	0. 17-0. 19	5. 6-6. 5	Moderate.
100	100	95-100	95-100	<0. 06	0. 17-0. 19	6. 1-8. 0	High.
100	100	95-100	95-100	0. 20-0. 63	0. 17-0. 19	6. 6-8. 0	Moderate.
100	100	95-100	95-100	0. 06-0. 20	0. 17-0. 19	5. 6-6. 5	High.
100	100	95-100	95-100	<0. 06	0. 17-0. 19	5. 6-8. 0	High.
100	100	95-100	95-100	0. 20-0. 63	0. 17-0. 19	6. 6-8. 0	Moderate.
100	100	90-100	70-90	0. 63-2. 00	0. 17-0. 19	5. 6-6. 5	Low.
100	100	95-100	85-95	0. 20-0. 63	0. 17-0. 19	5. 6-8. 0	Moderate.
100	100	95-100	95-100	<0. 06	0. 17-0. 19	6. 1-8. 0	High.
100	100	90-100	70-90	0. 63-2. 00	0. 17-0. 19	5. 6-6. 5	Moderate.
100	100	95-100	85-95	0. 20-0. 63	0. 17-0. 19	5. 6-6. 5	High.
95-100	95-100	90-100	80-95	0. 20-0. 63	0. 17-0. 19	6. 1-8. 0	High.
100	100	90-100	70-90	0. 63 2. 00	0. 17-0. 19	5. 6-7. 3	Moderate.
100	100	95-100	85-95	0. 20-0. 63	0. 17-0. 19	5. 6-7. 3	Moderate.
100	100	95-100	90-95	0. 06-0. 20	0. 17-0. 19	5. 6-7. 8	High.
100	100	95-100	90-95	0. 06-0. 20	0. 17-0. 19	5. 6-7. 8	High.
100	100	95-100	85-95	0. 20-0. 63	0. 17-0. 19	5. 6-7. 3	Moderate.
100	100	95-100	90-95	0. 06-0. 20	0. 17-0. 19	5. 6-7. 8	High.
95-100	95-100	90-100	80-95	0. 63-2. 00	0. 17-0. 19	6. 6-8. 0	Moderate.
95-100	95-100	90-100	80-95	0. 20-0. 63	0. 17-0. 19	5. 6-6. 5	Moderate.
95-100	95-100	90-100	80-95	0. 06-0. 20	0. 17-0. 19	5. 6-8. 0	High.
95-100	95-100	90-100	80-95	0. 20-0. 63	0. 17-0. 19	5. 6-6. 5	Moderate.
95-100	95-100	90-100	80-95	0. 06-0. 20	0. 17-0. 19	5. 6-8. 0	High.

TABLE 5.—*Interpretations of*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil, which may

Soil series and map symbols	Suitability as source of— Topsoil	Sand and gravel	Road subgrade [1]	Road fill [1]	Soil features affecting— Highway location [1]	Dikes and levees	Farm ponds: Reservoir areas
Alluvial land and Reading soils: Ar. Properties variable; onsite investigation required.							
Chase: Ch	Surface layer good; subsoil poor.	Unsuitable	Poor: high shrink-swell potential.	Fair: moderate to low stability.	Slow permeability; subject to occasional flooding; high shrink-swell potential; 0 to 1 percent slopes.	Moderate to low stability.	Not applicable.
*Clime: Cs. For interpretations of the Sogn soil, refer to the Sogn series.	Fair	Unsuitable	Fair: moderate stability.	Good	Bedrock at depth of 2 to 3½ feet; possible seepage; moderate plasticity; irregular topography; 5 to 20 percent slopes.	Not applicable.	Bedrock at depth of 2 to 3½ feet may cause seepage.
Dwight: Dh	Poor	Unsuitable	Poor: high shrink-swell potential.	Poor: low stability; dispersed subsoil.	High plasticity; very slow internal drainage; dispersed subsoil; 1 to 3 percent slopes.	Low stability; subject to cracking.	Very slow permeability; 1 to 3 percent slopes.
*Florence: Fc, Fe. For interpretations of the Labette soil in Fe, refer to the Labette series.	Poor	Fair for road gravel.	Good to poor, depending on size of chert fragments.	Good	Angular chert fragments make up 50 to 85 percent; irregular topography; limestone at depth of 3½ to 5 feet; 5 to 15 percent slopes.	Angular chert fragments make up 50 to 85 percent; limestone at depth of 3½ to 5 feet.	Fractured rock may cause seepage.
Irwin:							
Ic, Id, Ie	Surface layer fair; subsoil poor.	Unsuitable.	Poor: high shrink-swell potential.	Fair: low stability.	High plasticity; very slow permeability; 0 to 5 percent slopes.	Low stability; subject to cracking.	Very slow permeability; 0 to 5 percent slopes.
In, Io	Poor	Unsuitable.	Poor: high shrink-swell potential.	Fair: low stability.	High plasticity; very slow permeability; 0 to 5 percent slopes.	Low stability; subject to cracking.	Very slow permeability; 0 to 5 percent slopes.

See footnotes at end of table.

engineering properties

have different interpretations. For this reason the reader should follow carefully the instructions for referring to another series in this column]

Soil features affecting—Continued					Soil limitations for sewage disposal—	
Farm ponds—Continued: Embankments [2]	Agricultural drainage	Terraces and diversions	Grassed waterways	Foundations for low buildings	Septic tank filter fields	Sewage lagoons
Not applicable	Moderately well drained; slow permeability; subject to occasional flooding.	Not applicable.	Not applicable.	High shrink-swell potential; slow permeability.	Severe: slow permeability; subject to occasional flooding.	Severe where subject to flooding; slight where protected from flooding.
Moderate stability; moderate shrink-swell potential; limited borrow material.	Not applicable	Not applicable	Not applicable	No adverse features if on shale.	Severe: moderately slow permeability; 5 to 20 percent slopes; bedrock within a depth of 2 to 3½ feet; possible seepage.	Severe: bedrock at depth of 2 to 3½ feet; 5 to 20 percent slopes.
Low stability; subject to cracking; dispersed subsoil.	Small shallow depressions in some areas; very slow permeability.	Thin surface layer; dense, clayey subsoil.	Thin surface layer; dense, clayey subsoil; grass difficult to establish.	Low shear strength; high shrink-swell potential.	Severe: very slow permeability.	Moderate: bedrock at depth of 3½ to 5 feet; low stability.
Borrow material limited and cherty; possible seepage.	Not applicable	Not applicable	Not applicable	No adverse features.	Severe: moderately slow permeability.	Severe: 50 to 85 percent chert fragments; 5 to 15 percent slopes.
Low stability; high shrink-swell potential; subject to cracking.	Not applicable	Clayey subsoil; very slow permeability.	Clayey subsoil	High shrink-swell potential.	Severe: very slow permeability.	Slight where slopes are less than 2 percent; moderate where slopes are 2 to 5 percent; bedrock at depth of less than 5 feet in places.
Low stability; high shrink-swell potential; subject to cracking.	Not applicable	Clayey subsoil; very slow permeability.	Clayey surface layer that crusts; grass difficult to establish.	High shrink-swell potential.	Severe: very slow permeability.	Slight where slopes are less than 2 percent; moderate where slopes are 2 to 5 percent; bedrock at depth of less than 5 feet in places.

TABLE 5.—*Interpretations of*

Soil series and map symbols	Suitability as source of— Topsoil	Sand and gravel	Road subgrade [1]	Road fill [1]	Soil features affecting— Highway location [1]	Dikes and levees	Farm ponds: Reservoir areas
*Ivan: Iv. For interpretations of the Kennebec soil, refer to the Kennebec series.	Good	Unsuitable.	Poor: low stability.	Good	Subject to frequent flooding; 0 to 1 percent slopes.	No adverse features.	Not applicable.
Kennebec. Mapped only with soils of the Ivan series.	Good	Unsuitable.	Poor: low stability.	Good	Subject to frequent flooding; 0 to 1 percent slopes.	No adverse features.	Not applicable.
*Kipson: Ks. For interpretations of the Sogn soil, refer to the Sogn series.	Poor: limited quantity.	Unsuitable.	Fair to poor: low stability.	Fair: erodible.	Shale at depth of 1 to 1½ feet; irregular topography; erodible; 3 to 15 percent slopes.	Limited borrow material; possible loose rocks.	Shale at depth of 1 to 1½ feet; moderate permeability.
*Labette: Lb, Ld, Le. For interpretations of the Dwight soil in Ld and of the Sogn soil in Le, refer to their respective series.	Surface layer good; subsoil poor.	Unsuitable	Poor: moderate to high shrink-swell potential.	Fair: moderate to low stability.	Limestone at depth of 1½ to 3½ feet; moderate to high shrink-swell potential; 2 to 5 percent slopes.	Moderate to low stability; limestone at depth of 1½ to 3½ feet.	Limestone at depth of 1½ to 3½ feet; possible seepage.
Ladysmith: Ls	Surface layer fair; subsoil poor.	Unsuitable	Poor: high shrink-swell potential.	Fair: low stability.	Very slow permeability; high plasticity; 0 to 2 percent slopes.	Low stability; subject to cracking.	Slopes of 0 to 2 percent.
Lt	Poor	Unsuitable	Poor: high shrink-swell potential.	Fair: low stability.	Very slow permeability; high plasticity; 1 to 2 percent slopes.	Low stability; subject to cracking.	Slopes of 1 to 2 percent.
Mason: Mr. The interpretations also apply to the Reading soil in this unit.	Good	Unsuitable	Poor: moderate stability.	Fair to good: moderate stability.	Subject to occasional flooding; 0 to 1 percent slopes.	Moderate stability and compaction.	Slopes of 0 to 1 percent.

See footnotes at end of table.

engineering properties—Continued

Soil features affecting—Continued					Soil limitations for sewage disposal—	
Farm ponds—Continued: Embankments [2]	Agricultural drainage	Terraces and diversions	Grassed waterways	Foundations for low buildings	Septic tank filter fields	Sewage lagoons
Not applicable	Not applicable	Not applicable	Not applicable	Subject to frequent flooding.	Severe: subject to frequent flooding.	Moderate where protected from flooding; severe where subject to flooding; moderate permeability.
Not applicable	Not applicable	Not applicable	Not applicable	Subject to fre-frequent flooding.	Severe: subject to frequent flooding.	Moderate where protected from flooding; severe where subject to flooding; moderate permeability.
Limited borrow material.	Not applicable	Shale at depth of 1 to 1½ feet; erodible.	Shale at depth of 1 to 1½ feet; erodible.	Shale at depth of 1 to 1½ feet.	Severe: shale at depth of 1 to 1½ feet.	Severe: shale at depth of 1 to 1½ feet.
Limestone at depth of 1½ to 3½ feet; moderate to low stability; moderate to high shrink-swell potential.	Not applicable	Limestone at depth of 1½ to 3½ feet; clayey subsoil.	Limestone at depth of 1½ to 3½ feet; clayey subsoil.	Limestone at depth of 1½ to 3½ feet; moderate to high shrink-swell potential.	Severe: slow permeability; limestone at depth of 1½ to 3½ feet.	Severe: limestone at depth of 1½ to 3½ feet.
Low stability; high plasticity; subject to cracking.	Moderately well drained or somewhat poorly drained; very slow permeability; 0 to 2 percent slopes.	Clayey subsoil	Clayey subsoil	High shrink-swell potential.	Severe: very slow permeability.	Slight.
Low stability; high plasticity; subject to cracking.	Moderately well drained; very slow permeability; 1 to 2 percent slopes.	Clayey subsoil	Clayey subsoil; surface layer crusts; difficult to establish grass.	High shrink-swell potential.	Severe: very slow permeability.	Slight.
Moderate stability and compaction.	Not applicable	Not applicable	Subject to occasional flooding.	Moderate shear strength; subject to occasional flooding.	Severe: moderately slow permeability; subject to occasional flooding.	Severe where subject to flooding; slight where protected from flooding.

TABLE 5.—*Interpretations of*

Soil series and map symbols	Suitability as source of— Topsoil	Sand and gravel	Road subgrade [1]	Road fill [1]	Soil features affecting— Highway location [1]	Dikes and levees	Farm ponds: Reservoir areas
Osage: Os	Poor	Unsuitable	Poor: high shrink-swell potential.	Fair: low stability.	Very slow permeability; subject to occasional flooding; high plasticity; poor surface drainage; 0 to 1 percent slopes.	Low stability; subject to cracking.	Slopes of 0 to 1 percent.
Reading: Rd	Good	Unsuitable.	Poor: moderate to high shrink-swell potential.	Fair to good: moderate stability.	Slopes of 0 to 3 percent.	Moderate stability and compaction.	Slopes of 0 to 3 percent.
Smolan:							
Sm	Surface layer good; subsoil poor.	Unsuitable.	Poor: moderate to high shrink-swell potential.	Fair: low stability.	Slopes of 1 to 3 percent; high plasticity.	Low stability; subject to cracking.	Slopes of 1 to 3 percent.
Sn	Surface layer fair; subsoil poor.	Unsuitable.	Poor: moderate to high shrink-swell potential.	Fair: low stability.	Slopes of 2 to 6 percent; high plasticity.	Low stability; subject to cracking.	Slopes of 2 to 6 percent.
Sogn. Mapped only in complexes with Clime, Kipson, and Labette soils.	Poor	Unsuitable.	Poor: moderate shrink-swell potential.	Good: amount is limited.	Limestone at depth of ½ to 1½ feet; moderate plasticity; 2 to 8 percent slopes.	Limestone at depth of ½ to 1½ feet.	Limestone at depth of ½ to 1½ feet.
Tully:							
Ts	Surface layer good; subsoil poor.	Unsuitable	Poor: high shrink-swell potential.	Fair: low stability.	Slopes of 3 to 7 percent; high plasticity; slow permeability.	Low stability; subject to cracking.	Slow permeability.
Tt	Surface layer fair; subsoil poor.	Unsuitable	Poor: high shrink-swell potential.	Fair: low stability.	Slopes of 3 to 7 percent; high plasticity; slow permeability.	Low stability; subject to cracking.	Slow permeability.
Ty. Properties variable; onsite investigation required.							

[1] NORMAN CLARK, engineer of soils, and HERBERT E. WORLEY, soils research engineer, Kansas State Highway Commission, assisted in preparing these columns.

engineering properties—Continued

Soil features affecting—Continued					Soil limitations for sewage disposal—	
Farm ponds—Continued: Embankments [2]	Agricultural drainage	Terraces and diversions	Grassed waterways	Foundations for low buildings	Septic tank filter fields	Sewage lagoons
Low stability; subject to cracking.	Poorly drained; subject to occasional flooding; very slow permeability.	Not applicable	Not applicable	High shrink-swell potential; subject to occasional flooding.	Severe: very slow permeability; subject to occasional flooding.	Severe where subject to flooding; slight where protected from flooding.
Moderate stability and compaction.	Not applicable	No adverse features.	Slopes of 0 to 3 percent.	Moderate to high shrink-swell potential.	Severe: moderately slow permeability.	Slight where slopes are less than 2 percent; moderate where slopes are 2 to 3 percent.
Low stability; moderate to high shrink-swell potential.	Not applicable	No adverse features.	Subject to siltation; moderately erodible.	Low shear strength; moderate to high shrink-swell potential.	Severe: slow permeability.	Slight where slopes are less than 2 percent; moderate where slopes are more than 2 percent.
Low stability; moderate to high shrink-swell potential.	Not applicable	No adverse features.	Subject to siltation; moderately erodible.	Low shear strength; moderate to high shrink-swell potential.	Severe: slow permeability.	Moderate: slopes of 2 to 6 percent.
Limestone at a depth of ½ to 1½ feet; very limited borrow material.	Not applicable	Not applicable	Not applicable	Limestone at depth of ½ to 1½ feet.	Severe: limestone at depth of ½ to 1½ feet.	Severe: limestone at depth of ½ to 1½ feet.
Low stability; subject to cracking.	Not applicable	Clayey subsoil	Clayey subsoil	High shrink-swell potential.	Severe: slow permeability.	Moderate: slopes of 3 to 7 percent.
Low stability; subject to cracking.	Not applicable	Clayey subsoil	Clayey subsoil	High shrink-swell potential.	Severe: slow permeability.	Moderate: slopes of 3 to 7 percent.

[2] Embankments more than about 25 feet high were not considered.

In the Unified system (*12*), soils are classified according to particle-size distribution, plasticity, liquid limit, and content of organic matter. Soils are grouped in 15 classes. There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example CH or CL.

Soil properties significant in engineering

Table 4 provides estimates of soil properties important to engineering. The estimates are based on field classification and descriptions, physical and chemical tests of selected representative samples, test data from comparable soils in adjacent areas, and from detailed experience in working with the individual kinds of soil in the survey area. Engineering test data were not available for soils in Morris County.

Because the properties estimated in table 4 are for a typical profile, some variation from the values given can be expected. A soil designated by a given name varies slightly from place to place, and some mapping units contain small areas of contrasting soils.

Most of the soils in the county are underlain by various layers of limestone and shale. Depth to rock or shale varies widely within short distances, and can be a problem where foundation construction to bedrock is of engineering importance.

A seasonal high water table does not occur in Morris County.

USDA texture is determined by the relative proportions of sand, silt, and clay in soil material that is less than 2.0 millimeters in diameter. "Sand," "silt," "clay," and some of the other terms used in the USDA textural classification are defined in the Glossary.

The columns that show percentage passing sieves of various sizes indicate the relative amounts of coarse-grained and fine-grained material. Sands and coarser textured materials do not pass through a No. 200 sieve, but silt and clay pass through a sieve of that size. Only that material smaller than 3 inches in diameter is considered in these columns. The percentages are based on the assumption that material up to and including 3 inches in diameter equal 100 percent.

Permeability, as used in table 4, relates only to movement of water downward through undisturbed and uncompacted soil. It does not include lateral seepage. The estimates are based on structure and porosity of the soil. Plowpans, surface crusts, and other properties resulting from use of the soils are not considered.

Available water capacity is the estimate of the amount of capillary water in the soil that is available for plant use after all free water has drained away.

Reaction is the degree of acidity or alkalinity of a soil, expressed as a pH value. The pH value and relative terms used to describe soil reaction are explained in the Glossary.

Shrink-swell potential is an indication of the volume change to be expected of the soil material with changes in moisture content. Shrinking and swelling of soils cause much damage to building foundations, roads, and other structures. A *high* shrink-swell potential indicates hazard to the maintenance of structures built in, on, or with material having this rating.

Information on geology and construction-material resources is available in Geological Survey Bulletin 1060-A (*13*).

Engineering interpretations of soils

Table 5 contains information that is useful to engineers and others who plan to use soil material in construction of highways, farm facilities, buildings, and sewage disposal systems. Undesirable soil features are also given. The ratings and other interpretations in this table are based on estimated engineering properties of the soils shown in table 4; on available test data on soils in surrounding areas; and on field experience.

The following paragraphs explain most of the column headings used in table 5.

Topsoil is a term used to designate a fertile soil or soil material, ordinarily rich in organic matter, used as a topdressing for lawns, gardens, roadbanks, and the like. The suitability ratings of *good*, *fair*, or *poor* are for the entire profile, unless a specific horizon is rated.

Sand and gravel ratings are based on the probability that delineated areas of the soil contain deposits of sand and gravel. There are no deposits of sand in Morris County. The Florence soils are a fair source of angular chert.

Hard limestone ledges outcrop in some areas of the county. Most of these limestone ledges make excellent road-surfacing material when quarried and crushed.

Road subgrade (upper part of road fill) and road fill are materials used to build embankments. The ratings indicate predicted performance of soil material moved from borrow areas for these purposes.

Highway location is influenced by features of the undisturbed soil that affect construction and maintenance of highways. The soil features shown in table 5, favorable as well as unfavorable, are the principal ones that affect the location of highways.

Dikes and levees are low structures designed to impound or divert water. The soil features mentioned in table 5 are those that affect use of the soil as material for construction of low dikes and levees.

Farm pond reservoir areas are affected mainly by loss of water through seepage, and the soil features are those that influence such seepage.

Farm pond embankments serve as dams. Features of both subsoil and substratum are important to the use of soils for constructing embankments.

Agricultural drainage is affected by those features and qualities of the soil that influence the installation and performance of surface and subsurface drainage practices.

Terraces and diversions consider those features that affect their stability or hinder layout and construction.

Grassed waterways involve those soil features that hinder layout and construction and that affect the establishment, growth, and maintenance of plant cover.

Foundations for low buildings are affected chiefly by features of the undisturbed soil that influence its capacity to support low buildings having normal foundation loads. Specific values of bearing strength are not assigned.

Septic tank filter fields are affected mainly by permeability, depth to water table, and susceptibility to flooding. The degree of limitation and principal reasons for assigning moderate or severe limitations are given.

Sewage lagoons are influenced chiefly by such soil features as permeability, depth to water table, and slope. The degree of limitation and principal reasons for assigning moderate or severe limitations are given.

Soil Interpretations for Recreational Uses [7]

Morris County, easily accessible to urban centers of population, provides excellent opportunities for outdoor recreation. Council Grove Reservoir, completed in 1965, has a surface area of 3,280 acres. Fishing, boating, skiing, picnicking, camping, and related activities make this area popular for water-based recreation.

Council Grove Lake, constructed as a water supply for the city of Council Grove, offers multiple opportunities for recreation. Cabin sites, as well as sites for many water activities, are available on a permit basis.

In table 6 the soils of Morris County are rated by degree and kind of limitation for stated recreational uses. The ratings are *slight*, *moderate*, and *severe*. A rating of slight means that the soil has few or no limitations for the use specified or that the limitations can be easily overcome. A rating of moderate indicates that some planning and engineering practices are needed to overcome the limitations. A rating of severe indicates that the soil is poorly suited to the use specified and that intensive engineering practices, as well as a large investment, are needed to overcome the limitations.

Campsites for intensive use.—These sites are used for tents, small camp trailers, and activities related to camping. The sites should be suitable for heavy foot or vehicular traffic, for they are used frequently during the camping season. The suitability of soil for producing vegetation should be considered separately in selecting sites for intensive camping.

Picnic areas.—The ratings in table 6 are based only on soil features, such as drainage and texture of the surface layer, though other factors, such as lakes, trees, or beauty of the landscape, may add to the desirability of a picnic area.

Play areas for intensive use.—Among these areas are playgrounds, baseball diamonds, football fields, and badminton courts. Generally required is a soil that is nearly level and has good drainage and a surface free of rocks. It is assumed that a thick vegetative cover can be established and maintained where needed.

Trails and paths.—Within this category are trails for cross-country hiking, bridle paths, and other sites for nonintensive uses. Generally, the soils should not need much grading or shaping. The ratings are based on soil features only and do not include other factors, such as beauty of the landscape, that are important when selecting sites for trails or paths.

[7] By JACK WALSTROM, biologist, Soil Conservation Service.

TABLE 6.—*Degree and kind of soil limitations for recreational uses*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil, which may have different limitations to use. For this reason the reader should follow carefully the instructions for referring to another series in the first column of this table]

Soil series and map symbols	Campsites for intensive use	Picnic areas	Play areas for intensive use	Trails and paths
Alluvial land and Reading soils: Ar. Limitations apply to both components of this unit.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.
Chase: Ch	Severe: subject to flooding; silty clay loam surface layer; slow permeability.	Moderate: silty clay loam surface layer; subject to flooding.	Moderate: silty clay loam surface layer; slow permeability; subject to flooding.	Moderate: silty clay loam surface layer.
*Clime: Cs For limitations of Sogn part, see Sogn series.	Severe: silty clay surface layer.	Severe: silty clay surface layer.	Severe: silty clay surface layer.	Severe: silty clay surface layer.
Dwight: Dh	Severe: very slow permeability.	Moderate: moderately well drained.	Severe: very slow permeability.	Moderate: very slow permeability.
*Florence: Fc, Fe For limitations of the Labette soil in Fe, see Labette series.	Moderate: 5 to 15 percent slopes; moderately slow permeability.	Moderate: 5 to 15 percent slopes.	Severe: 5 to 15 percent slopes.	Moderate: cherty silt loam surface layer.
Irwin:				
Ic, Id, Ie	Severe: very slow permeability.	Moderate: silty clay loam surface layer.	Severe: very slow permeability.	Moderate: silty clay loam surface layer.
In, Io	Severe: very slow permeability.	Severe: silty clay and silty clay loam surface layer.	Severe: very slow permeability.	Severe: silty clay and silty clay loam surface layer.

TABLE 6.—*Degree and kind of soil limitations for recreational uses*—Continued

Soil series and map symbol	Campsites for intensive use	Picnic areas	Play areas for intensive use	Trails and paths
*Ivan: Iv. For limitations of Kennebec soil, see Kennebec series.	Severe: subject to flooding.	Moderate: subject to flooding.	Severe: subject to flooding.	Moderate: subject to flooding.
Kennebec. Mapped only with soils of the Ivan series.	Severe: subject to flooding.	Moderate: subject to flooding.	Severe: subject to flooding.	Moderate: subject to flooding.
*Kipson: Ks. For limitations of the Sogn soil, see Sogn series.	Moderate: 3 to 15 percent slopes.	Moderate: 3 to 15 percent slopes.	Severe: 3 to 15 percent slopes; shallow depth.	Slight.
*Labette: Lb, Ld, Le. For limitations of the Dwight soil in Ld, and of the Sogn soil in Le, see their respective series.	Moderate: silty clay loam surface layer; slow permeability.	Moderate: silty clay loam surface layer.	Moderate: 2 to 5 percent slopes; silty clay loam surface layer; slow permeability; moderately deep over bedrock.	Moderate: silty clay loam surface layer.
Ladysmith:				
Ls	Severe: very slow permeability.	Moderate: silty clay loam surface layer.	Severe: very slow permeability.	Moderate: silty clay loam surface layer.
Lt	Severe: very slow permeability; heavy silty clay loam surface layer.	Severe: heavy silty clay loam surface layer.	Severe: very slow permeability; heavy silty clay loam surface layer.	Severe: heavy silty clay loam surface layer.
Mason: Mr. Limitations apply to both components of this unit.	Severe: subject to flooding; moderately slow permeability.	Moderate: subject to flooding.	Moderate: subject to flooding; moderately slow permeability.	Slight.
Osage: Os	Severe: poorly drained; wetness; very slow permeability; silty clay surface layer.	Severe: poorly drained; wetness; silty clay surface layer.	Severe: poorly drained; wetness; very slow permeability; silty clay surface layer.	Severe: poorly drained; wetness; silty clay surface layer.
Reading: Rd	Moderate: moderately slow permeability.	Slight.	Moderate: moderately slow permeability.	Slight.
Smolan:				
Sm	Moderate: slow permeability.	Slight.	Moderate: slow permeability.	Slight.
Sn	Moderate: slow permeability; silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: slow permeability; silty clay loam surface layer; 2 to 6 percent slopes.	Moderate: silty clay loam surface layer.
Sogn. Mapped only with the Clime, Kipson, and Labette soils.	Severe: rock outcrop.	Severe: rock outcrop.	Severe: shallow depth; rock outcrop.	Severe: rock outcrop.
Tully:				
Ts, Tt	Moderate: slow permeability; silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: slow permeability; silty clay loam surface layer.	Moderate: silty clay loam surface layer.
Ty	Moderate: slow permeability; silty clay loam surface layer; 5 to 15 percent slopes.	Moderate: silty clay loam surface layer; 5 to 15 percent slopes.	Severe: 5 to 15 percent slopes.	Moderate: silty clay loam surface layer.

Formation and Classification of the Soils

In this section the factors that have affected the formation and composition of soils in Morris County are discussed. The current system of soil classification is described and the soils are placed in some classes of this system.

Factors of Soil Formation

Soil is produced by soil-forming processes acting on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that is formed and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil profile. It may be much or little, but some time is always required for differentiation of soil horizons. Usually, a long time is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil development are unknown.

Parent material

Parent material is the unconsolidated mass in which soil is formed. Parent material is formed by the weathering of rocks through the processes of freezing and thawing, abrasion, and erosion; by chemical process; and by deposition from wind and water.

The soils in Morris County formed in material weathered from limestone and shale of the lower Permian system of rocks (*6*), from silts and clays of the Sanborn Formation of Pleistocene age (*5*), and from alluvium of more recent time.

The exposure of the Permian system of rocks, in Morris County, includes limestone and shale members of the Sumner group located in the southwestern part of the county, all of the Chase group, and part of the Council Grove group located in the southeastern part of the county (*13*). Examples of soils that formed from these residual materials are the Kipson soils, formed in material weathered from silty, calcareous shale; Florence soils, formed in material weathered from cherty limestone; Clime soils, formed in material weathered from clayey, calcareous shale; and Sogn and Labette soils, formed in material weathered from various limestones throughout the county.

Some soils, such as the Dwight and Irwin soils, appear to have formed in parent material derived from more than one source. The lower part of these soils probably formed in material weathered from the underlying shale, but in many places the upper part apparently formed in transported material.

Some soils, such as those of the Tully series, formed in colluvial-alluvial slopewash, mostly of residuum. The Ladysmith soils apparently formed entirely in eolian material of the Sanborn Formation. Smolan soil formed in older, reddish-colored silts and clays.

The Ivan and Kennebec soils formed in alluvial sediment deposited by streams on their present flood plains. The Mason, Reading, and Chase soils formed in materials laid down by present-day streams in earlier cycles of deposition. They are on terraces, where they are much less susceptible to flooding than are the Ivan and Kennebec soils. The clayey Osage soils formed in backwater areas of fine-textured sediment.

Climate

Climate has played an important role in the formation of soils in this county. Precipitation and temperature have been the most active elements of climate in changing the soil material into a soil profile. These climatic agents have caused the three principal types, or processes, of weathering—physical, chemical, and biological—to take place. The processes of weathering are all interrelated.

Morris County has a subhumid, continental climate. Precipitation is quite variable from month to month and from year to year, and the moisture content of the soils fluctuates widely. The soils become quite dry during prolonged dry periods, but during wet periods, moisture penetrates into the substratum of some of them. The concretionary masses in the lower part of the subsoil and in the underlying material are evidence of the deep penetration of moisture. Most of the soils in the county have had some bases leached from the surface layer and the upper part of the subsoil. The surface layer and upper part of the subsoil are more acid in reaction than are the deeper horizons. Soils such as those of the Ivan series, which formed in recent deposits of calcareous material, show little evidence of leaching.

Temperature is important to soil development in several ways. The growth and activity of organisms normally increases as temperature increases. The rate of chemical reaction also increases with a rise in temperature and affects this weathering of minerals and the decomposition of organic material. The alternating cold and warm temperatures in winter cause freezing and thawing of the soil material. This freezing and thawing tends to change the soil structure by forming soil material into aggregates.

Weather records in Morris County show that the winters are rather short and cold, and the summers are quite long and hot. Most of the annual precipitation falls during the growing season.

Plant and animal life

Two important functions of plants and animals in the soil-forming process are the furnishing of organic matter to the soil and the bringing up of plant nutrients from the underlying layers to the surface layer. Trunks, stems,

leaves, and roots of plants are the primary sources of organic matter. This organic matter modifies the color, structure, and other soil properties physically and chemically, and it creates a more favorable environment for biological activity within the soil.

Burrowing animals contribute much by mixing various soil horizons and, in some cases, by bringing fresh material into the surface horizons. Earthworms feed on organic matter and make channels, and in this way they thoroughly mix the soil in which they live. Their activity is especially noticeable in the Mason, Reading, Chase and other soils that have a high content of organic matter. Micro-organisms also play an important part in the soil-forming process by helping to decay plant residue into organic matter.

Most soils in Morris County formed under tall grasses. These grasses supply the soil with enormous amounts of plant residue that decays into organic matter that darkens the surface layer of the soil and strengthens its structure.

Relief

Relief, or lay of the land, influences the formation of soils through its effect upon drainage, runoff, erosion, and vegetation. On sloping soils some of the rain runs off before it has a chance to enter the soil. Also, steep soils erode more readily than gently sloping soils.

Soils that are nearly level or that occur in low places where surface drainage is poor are likely to have a gray or dark color and a mottled subsoil. Osage soils in Morris County is an example.

Nearly level and gently sloping soils on uplands generally have more strongly developed profiles than the steep soils. More water percolates through them, and less soil material is removed from the surface layer because surface runoff is slower.

Time

The length of time required for the formation of a given soil depends largely on the other factors of soil formation. Soil formation proceeds more rapidly in permeable, loamy material than in slowly permeable, clayey material. Also, soil formation is more rapid for nearly level soil than for steep soil, because the nearly level soil has less runoff and erosion.

As water moves through the soil profile over a long period of time, some of the soluble substances and fine particles are leached from the surface layer and deposited in the subsoil. The amount of leaching in a given soil depends on the amount of water that penetrates the soil, and this, in turn, depends on the elapsed time. For example, Ivan soils, which are young and formed in recent alluvium, show little effect of leaching in their profiles. In contrast, Irwin soils, which have well developed horizons, were formed over a longer period of time.

Classification of the Soils

Classification consists of an orderly grouping of soils according to a system designed to make it easier to remember soil characteristics and interrelationships. Classification is useful in organizing and applying the results of experience and research.

Soils are placed in narrow classes for discussion in detailed soil surveys and for application of knowledge within farms and fields. The many thousands of narrow classes are then grouped into progressively fewer and broader classes in successively higher categories, so that information can be applied to large geographic areas.

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 (*2*) and revised later (*9*). The system currently used by the National Cooperative Soil Survey (*11*) was developed in the early sixties and adopted in 1965, and supplemented in March 1967 and in September 1968. The system is under continual study (*8*), and readers interested in the development of the system should refer to the latest literature available.

The current system of classification has six categories. Beginning with the most inclusive, these categories are the order, the suborder, the great group, the subgroup, the family, and the series. In this system the criteria for classification are soil properties that are observable or measurable, but the properties are selected so that soils of similar genesis, or mode of origin, are grouped together. The placement of some soil series in the current system of classification, particularly in families, may change as more precise information becomes available.

Table 7 shows the classification of each soil series of Morris County by family, subgroup, and order, according to the current system.

ORDER.—Ten soils orders are recognized. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate these soil orders are those that tend to give broad climatic groupings of the soils. The two exceptions to this are the Entisols and Histosols, which occur in many different kinds of climate. Table 7 shows that Mollisols are the only soil order in Morris County.

Mollisols formed under grass and have a thick, dark-colored surface horizon containing colloids dominated by bivalent cations. The soil material in these soils has not been mixed by shrinking and swelling.

SUBORDER.—Each order has been divided into suborders, primarily on the basis of the characteristics that seemed to produce classes that have the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging, or soil differences resulting from the climate or vegetation.

GREAT GROUPS.—Suborders are separated into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated or those that contain a pan that interferes with the growth of roots or movement of water. The features used are the self-mulching properties of clays, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), and the like. The great group is not shown separately in table 7, because it is the last word in the name of the subgroup.

SUBGROUP.—Great groups are divided into subgroups, one representing the central (typic) segment of the

TABLE 7.—*Classification of the soil series by higher categories*

[The soils in this table were classified in May 1969]

Soil series	Family	Subgroup	Order
Chase	Fine, montmorillonitic, mesic	Aquic Argiudolls	Mollisols.
Clime	Fine, mixed, mesic	Udic Haplustolls	Mollisols.
Dwight	Fine, montmorillonitic, mesic	Typic Natrustolls	Mollisols.
Florence	Clayey-skeletal, montmorillonitic, mesic	Udic Argiustolls	Mollisols.
Irwin [1]	Fine, mixed, mesic	Pachic Argiustolls	Mollisols.
Ivan	Fine-silty, mixed, mesic	Cumulic Hapludolls	Mollisols.
Kennebec [2]	Fine-silty, mixed, mesic	Cumulic Hapludolls	Mollisols.
Kipson	Loamy, mixed, mesic, shallow	Udorthentic Haplustolls	Mollisols.
Labette	Fine, mixed, mesic	Udic Argiustolls	Mollisols.
Ladysmith [3]	Fine, montmorillonitic, mesic	Pachic Argiustolls	Mollisols.
Mason [4]	Fine-silty, mixed, thermic	Typic Argiudolls	Mollisols.
Osage	Fine, montmorillonitic, noncalcareous, thermic	Vertic Haplaquolls	Mollisols.
Reading	Fine, mixed, mesic	Typic Argiudolls	Mollisols.
Smolan [1]	Fine, montmorillonitic, mesic	Pachic Argiustolls	Mollisols.
Sogn	Loamy, mixed, mesic	Lithic Haplustolls	Mollisols.
Tully [3]	Fine, mixed, mesic	Pachic Argiustolls	Mollisols.

[1] In Morris County some of these soils are taxadjuncts to the series, because they are not darkened so deeply as the defined range for the series.

[2] In Morris County the Kennebec soils are taxadjuncts to the series, because they are less acid than is normal for the series.

[3] In Morris County some of these soils are taxadjuncts to the series, because they have a thinner surface layer than the defined range for the series.

[4] In Morris County the Mason soils are taxadjuncts to the series, because they have an average annual soil temperature that is slightly less than normal for the series.

group, and others, called intergrades, that have properties of the group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group.

FAMILY.—Families are separated within a subgroup primarily on the basis of properties important to the growth of plants or behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence.

Additional Facts about the County

This section was written mainly for those unfamiliar with Morris County. History and population; physiography, drainage, and relief; water supply; farming; industry and resources; community facilities; transportation and markets; and the climate of the county are described. Farm statistics used are from records of the U.S. Bureau of the Census.

History and Population

The Kaw Indians were brought to what is now Morris County in 1847 and remained there until 1873, when they were moved to Oklahoma. The first white settlers also came to Morris County in 1847 and set up a trading post in Council Grove, the present county seat. The famous treaty of 1825, in which the Osage Indian Nation agreed to give a right-of-way for the Sante Fe Trail across their land, was made in Council Grove.

In 1860 the population of Morris County was 770. By 1870 the population had increased to 2,225. The increase continued for many years, and by 1910 the population was 12,397. Since that time, the population has declined. Figures of the U.S. Census show that the population was 6,953 in 1969.

Physiography, Drainage, and Relief

The soils are rather deeply dissected and strongly sloping in the eastern and southern parts of the county and in the northwestern corner. The divide that runs from the southwestern corner of the county through Burdick, Delavan, Wilsey, White City, and Dwight has a more subdued relief, and the soils are mostly gently sloping to nearly level.

The Neosho River and its tributaries drain the eastern and central three-fourths of the county. The Neosho River originates in the north-central part of Morris County and flows out at the southeastern corner. The southwestern part of the county is drained by Diamond and Middle Creeks, which join the Cottonwood River in Chase County. The northwestern part of the county is drained by Clarks Creek, which flows into the Kansas River. The last 3 major floods occurred in 1935, 1941, and 1951.

Elevations above sea level range from about 1,525 feet in the central and southwestern parts to about 1,125 feet on the Neosho River in the southeastern part of the county.

Water Supply

The underground water supply in Morris County is extremely variable. In the southwestern, western, west-central, and north-central parts of the county, water for domestic livestock can be obtained from drilled wells. The

towns of Dwight, Wilsey, and White City are served by wells. The lower reaches of the major streams generally have dependable quantities of underground water for livestock and general use. The water is of good quality. A dependable supply of underground water is not available in many other parts of the county.

Sources of surface water are wells, ponds, springs, lakes, and permanent streams. Council Grove Lake and the Council Grove Reservoir are located just above the city of Council Grove, and Lake Kahola is on the Chase County line in the southeastern part of the county. Ponds and a few dependable springs are located throughout the county.

Irrigation has been practiced to a limited extent in the lower part of the valley of the Neosho River. Water is not available in sufficient quantity for irrigating a large acreage.

Farming

Farming and ranching are the major enterprises in Morris County. It is believed that the first plowing in this county was done in the 1850's. Early settlers had considerable difficulty in obtaining title to land; therefore, extensive settlement of the county did not occur until the 1870's. The cutting of wild prairie hay was probably the first farming effort. Much of this hay was used by the Indian Agency located in Council Grove.

The number of farms and the land in farms has declined since 1935, when Morris County had 1,622 farms totaling 432,661 acres. In 1967 there were 836 farms and approximately 429,000 acres in farms. During this 32-year period, there was a small increase in the acreage used for range and a small decrease in the cultivated area.

The raising of cattle is a major enterprise in this county. In the early history of livestock production, summer grazing was the predominant use of the native range. In later years herds of cows increased considerably, but summer grazing is still practiced by some ranchers.

Corn was the most important cultivated crop grown in Morris County before World War I. Since that time, the production of wheat and sorghum has increased to the point where little corn is grown, except on the alluvial soils. The acreage in alfalfa has also increased, and soybeans have become an important crop in the last decade. According to records of the Kansas State Board of Agriculture, the acreages of harvested crops in 1968 were—

Wheat	45,000 acres
Sorghum for grain	35,000 acres
Alfalfa	20,000 acres
Corn for silage	6,280 acres
Soybeans	5,000 acres
Corn for grain	4,500 acres
Sorghum for silage	3,600 acres

Industry and Resources

Industries in addition to farming and ranching consist of two plastic plants and a milk processing plant.

Resources, other than soil and water, are a small amount of oil in the northeastern part of the county and a few minor gas wells in the south-central part. High quality limestone suitable for construction and building purposes is available in considerable quantity.

Community Facilities

Public recreation facilities are excellent for boating, fishing, swimming, and picnicking at both Council Grove City Lake and Council Grove Reservoir. A public hunting area has been established around parts of Council Grove Reservoir. A public swimming pool, a golf course, and tennis courts are available in Council Grove. Baseball and softball fields are located in Council Grove, Wilsey, Dwight, White City, and Burdick.

Transportation and Markets

Morris County has excellent railroad facilities. One line of a major railroad traverses the county in an east-west direction, running through Council Grove, Wilsey, and Delavan. The other line goes through Dwight and White City in the northern part of the county. A branch line of a major carrier goes through Burdick in the southwestern part of the county.

The county is crossed in an east-west direction by U.S. Highway No. 56, which runs through Council Grove, Wilsey, and Delavan. State Highway 177 traverses the county from north to south. State Highway 4 goes across the northern part of the county through White City and Dwight. In addition, the county has a good system of all-weather, farm-to-market roads.

Markets for all farm products are readily available. Most feed grains not used on the farm are sold locally for storage in elevators, and some excess crops are sold to owners of local feedlots. Livestock not sold locally are trucked to markets in Emporia, Manhattan, Wichita, Kansas City, and St. Joseph, Mo. Poultry, eggs, and milk are generally sold locally.

Climate [8]

Located in the heart of North America, Morris County has a typical continental climate. It has relatively cold winters, warm to hot summers, low to moderate humidity, light precipitation in winter, a pronounced rainfall peak late in spring and early in summer, and a moderate amount of wind. One of the important climatic controls is the Gulf of Mexico, 600 miles to the south-southeast. Morris County is frequently in the path of warm, moist air that flows from the Gulf. The collision of this air with colder air from northern latitudes accounts for a large part of the annual precipitation (*4*). Temperature and precipitation data are summarized in table 8. The probabilities of freezing temperature is shown in table 9.

Low-pressure storm systems affect the eastern part of Kansas in fall, winter, and spring, and they contribute to the overall climatic pattern. Morris County has an inflow of warm maritime air before the low-pressure systems arrive and outbreaks of cold, polar, continental air after the lows move eastward. This is the principal cause of the changeable weather in the area.

Average annual precipitation in the western part of Kansas is 16 inches. Precipitation increases eastward to more than 40 inches in the southeastern corner of Kansas. Morris County gets an average of about 32.5 inches of rain

[8] By MERLE J. BROWN, climatologist for Kansas, National Weather Service.

TABLE 8.—*Temperature and precipitation data*

[From records kept at Council Grove]

Month	Temperature				Precipitation		
	Average daily maximum [1]	Average daily minimum [1]	Two years in 10 will have at least 4 days with— Maximum temperatures equal to or higher than—	Two years in 10 will have at least 4 days with— Minimum temperature equal to or lower than—	Average total [1]	One year in 10 will have— Totals less than—	One year in 10 will have— Totals greater than—
	°F.	°F.	°F.	°F.	Inches	Inches	Inches
January	40. 2	18. 4	61	−1	0. 83	0. 50	1. 70
February	46. 0	22. 2	65	5	1. 11	. 14	1. 89
March	55. 9	30. 3	77	13	1. 87	. 41	3. 32
April	67. 9	42. 4	84	29	2. 88	1. 31	4. 91
May	76. 7	52. 2	90	39	4. 53	2. 29	7. 51
June	86. 2	62. 0	99	52	4. 64	1. 09	8. 72
July	92. 2	66. 3	105	57	3. 88	. 54	8. 82
August	91. 5	65. 2	104	55	3. 95	1. 10	7. 47
September	83. 4	56. 5	98	41	3. 49	1. 02	6. 78
October	71. 5	44. 6	88	30	2. 51	. 52	5. 11
November	56. 3	31. 1	73	16	1. 65	. 09	3. 75
December	43. 8	21. 9	62	6	1. 12	. 12	2. 33
Year	67. 6	42. 8	[2] 104	[3] −10	32. 46	24. 52	42. 63

[1] Data from records for period 1909–60.
[2] Average annual highest temperature, 1909–67.
[3] Average annual lowest temperature, 1909–67.

per year. The precipitation regime is typical of a climate that is controlled by land. Winters are characterized by cold, dry weather. Only 9 percent of the average annual precipitation occurs in December, January, and February. January, averaging 0.83 inch, is the driest month. About 72 percent of the average annual rainfall occurs during the growing season of April through September, and this distribution is of great significance to farming. It tends to minimize the damaging effects of hot weather and of the moderate to strong winds, which occasionally combine to produce high potential evapotranspiration rates during the warm season.

Much of the moisture falls as occasional showers during the night and early in the morning and as thundershowers in the months of April through October. Violent thunderstorms occur at times during these months, producing heavy rain, large hailstones, strong winds, and tornadoes. Severe storms generally are local in extent. However, they are of short duration, and cause damage in a variable and spotted pattern. In contrast to rainfall, the incidence of hail decreases from west to east across the State. Thus, damaging hailstorms are not so frequent in Morris County as in counties farther to the west in Kansas.

Fluctuations in the general atmospheric circulation occur often enough to produce a variable precipitation pattern from month to month and from year to year. Records at Council Grove, which date back to 1902, indicate the annual rainfall has ranged from 18.41 inches in 1966 to 54.73 inches in 1951. Several months since 1902

TABLE 9.—*Probabilities of last freezing temperature in spring and first in fall*

[Data for Council Grove]

Probability	Dates for stated probability and temperature				
	16° F. or lower	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower
Spring:					
1 year in 10 later than	March 30	April 7	April 11	April 25	May 6
2 years in 10 later than	March 24	April 1	April 6	April 20	May 1
5 years in 10 later than	March 12	March 22	March 28	April 10	April 20
Fall:					
1 year in 10 earlier than	November 10	October 29	October 21	October 14	October 4
2 years in 10 earlier than	November 16	November 3	October 25	October 19	October 8
5 years in 10 earlier than	November 28	November 14	November 4	October 28	October 19

have had no measurable precipitation; at the other extreme, 12.46 inches of rain fell during July 1951. Dry weather of several months' duration is not uncommon in Morris County, and droughts extending over a period of years may occur at irregular intervals. The drought of 1952 through 1956 was especially severe in Morris County and elsewhere in eastern Kansas.

Because of the continental climate, daily and annual temperature ranges are rather large (table 8). Average monthly temperature ranges from 29.3° F. in January to 79.3° in July. Temperature extremes for the period of record at Council Grove range from −32° to 115°.

The probabilities of the last freeze in spring and the first in fall in the central part of Morris County are given for five thresholds in table 9. The average freeze-free period is 182 days, and it extends from April 20 to October 19 (*3*). Because of the relatively long growing season, there generally is little crop loss from freezing weather in Morris County.

The prevailing wind is from the south. Winds are generally light to moderate in all seasons. Average monthly velocities are lowest late in summer and early in fall, gradually increasing to a maximum in spring.

With the exception of deficient rainfall in some growing seasons, climatic conditions in Morris County are generally favorable for successful farming. The percentage of possible sunshine, the growing season temperatures, and the seasonal distribution of precipitation all contribute to a favorable climate for farming.

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Glossary

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt. In this survey a soil described as clayey contains more than 35 percent clay.

Claypan. A compact, slowly permeable soil horizon that contains more clay than the horizon above and below it. A claypan is commonly hard when dry and plastic or stiff when wet.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A horizon and upper part of the B horizon and have mottling in the lower part of the B horizon and the C horizon.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be lacking or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

Forb. Any herbaceous plant, neither a grass nor a sedge, that is grazed on western ranges.

Gravelly soil material. From 15 to 50 percent of material, by volume, consists of rounded or angular rock fragments that are not prominently flattened and are up to 3 inches in diameter.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than in the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Leached layer. A layer from which the soluble materials have been dissolved and washed away by percolating water.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are these: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability. The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Mildly alkaline	7.4 to 7.8
Very strongly acid	4.5 to 5.0	Moderately alkaline	7.9 to 8.4
Strongly acid	5.1 to 5.5	Strongly alkaline	8.5 to 9.0
Medium acid	5.6 to 6.0	Very strongly alkaline	9.1 and higher
Slightly acid	6.1 to 6.5		
Neutral	6.6 to 7.3		

Relief. The elevations or inequalities of a land surface, considered collectively.

Runoff (hydraulics). The part of the precipitation upon a drainage area that is discharged from the area in stream channels. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. Individual rock or mineral fragments in soils having diameters ranging from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Slope. In this soil survey, the following are classes of slope used and their limits: *Nearly level,* 0 to 1 percent slopes; *gently sloping,* 1 to 3 percent slopes; *sloping,* 3 to 8 percent slopes; *moderately steep,* 8 to 20 percent slopes; and *steep,* more than 20 percent slopes.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. Technically, the part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Taxadjunct. A soil that does not fit in a series recognized in the classification system, but that differs from named soils in ways too small to be of consequence in interpreting their usefulness or behavior. Such soils are designated taxadjuncts to the series for which they are named.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted with flood plains, and are seldom subject to flooding. Marine terraces were deposited by the sea and are generally wide.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Upland (geology). Land consisting of material unworked by water in recent geologic time and lying, in general, at a higher elevation than the alluvial plain or stream terrace. Land above the lowlands along rivers.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. In referring to a capability unit, a range site, a woodland suitability group, or a windbreak suitability group, read the introduction to the section it is in for general information about its management. Woodland suitability groups are discussed on pages 30 and 31. Windbreak suitability groups are discussed on pages 31 and 32. Other information is given in tables as follows:

Acreage and extent, table 1, page 9.
Predicted yields, table 2, page 26.
Wildlife, table 3, page 33.
Engineering uses of the soils, tables 4 and 5, pages 34 through 43.
Degree and kind of soil limitations for recreational uses, table 6, page 45.

Map symbol	Mapping unit	Page	Capability unit	Range site		Woodland suitability group	Windbreak suitability group
			Symbol	Name	Page	Number	Number
Ar	Alluvial land and Reading soils	7	VIw-1	Loamy Lowland	28	1	A
Ch	Chase silty clay loam	9	IIw-2	Loamy Lowland	28	3	A
Cs	Clime-Sogn complex, 5 to 20 percent slopes	10					
	Clime part	--	VIe-1	Limy Upland	28	---	D
	Sogn part	--	VIe-1	Shallow Limy	29	---	G
Dh	Dwight silt loam, 1 to 3 percent slopes	11	IVe-2	Claypan	27	---	E
Fc	Florence cherty silt loam, 5 to 15 percent slopes	12	VIe-2	Loamy Upland	28	---	F
Fe	Florence-Labette complex, 2 to 12 percent slopes	12					
	Florence part	--	VIe-2	Loamy Upland	28	---	F
	Labette part	--	VIe-2	Loamy Upland	28	---	C
Ic	Irwin silty clay loam, 0 to 1 percent slopes	13	IIs-1	Clay Upland	27	---	C
Id	Irwin silty clay loam, 1 to 3 percent slopes	13	IIIe-1	Clay Upland	27	---	C
Ie	Irwin silty clay loam, 3 to 5 percent slopes	13	IIIe-6	Clay Upland	27	---	C
In	Irwin soils, 1 to 3 percent slopes, eroded	14	IIIe-3	Claypan	27	---	E
Io	Irwin soils, 3 to 5 percent slopes, eroded	14	IVe-1	Claypan	27	---	E
Iv	Ivan and Kennebec silt loams	15	IIw-1	Loamy Lowland	28	1	A
Ks	Kipson-Sogn complex, 3 to 15 percent slopes	16					
	Kipson part	--	VIe-1	Limy Upland	28	---	D
	Sogn part	--	VIe-1	Shallow Limy	29	---	G
Lb	Labette silty clay loam, 2 to 5 percent slopes	16	IIIe-5	Loamy Upland	28	---	C
Ld	Labette-Dwight complex, 1 to 3 percent slopes	17					
	Labette part	--	IIIe-4	Loamy Upland	28	---	C
	Dwight part	--	IIIe-4	Claypan	27	---	E
Le	Labette-Sogn complex, 2 to 8 percent slopes	17					
	Labette part	--	VIe-3	Loamy Upland	28	---	C
	Sogn part	--	VIe-3	Shallow Limy	29	---	G
Ls	Ladysmith silty clay loam, 0 to 2 percent slopes	18	IIs-1	Clay Upland	27	---	C
Lt	Ladysmith silty clay loam, 1 to 2 percent slopes, eroded	18	IIIe-3	Claypan	27	---	E
Mr	Mason and Reading silt loams, 0 to 1 percent slopes	19	I-1	Loamy Lowland	28	3	A
Os	Osage silty clay	19	IIIw-1	Clay Lowland	27	2	B
Rd	Reading silt loam, 1 to 3 percent slopes	20	IIe-1	Loamy Upland	28	3	A
Sm	Smolan silt loam, 1 to 3 percent slopes	21	IIe-2	Loamy Upland	28	---	C
Sn	Smolan silty clay loam, 2 to 6 percent slopes, eroded	21	IIIe-6	Clay Upland	27	---	C
Ts	Tully silty clay loam, 3 to 7 percent slopes	23	IIIe-2	Loamy Upland	28	---	C
Tt	Tully silty clay loam, 3 to 7 percent slopes, eroded	23	IIIe-6	Clay Upland	27	---	C
Ty	Tully soils, 5 to 15 percent slopes	23	VIe-2	Loamy Upland	28	---	C

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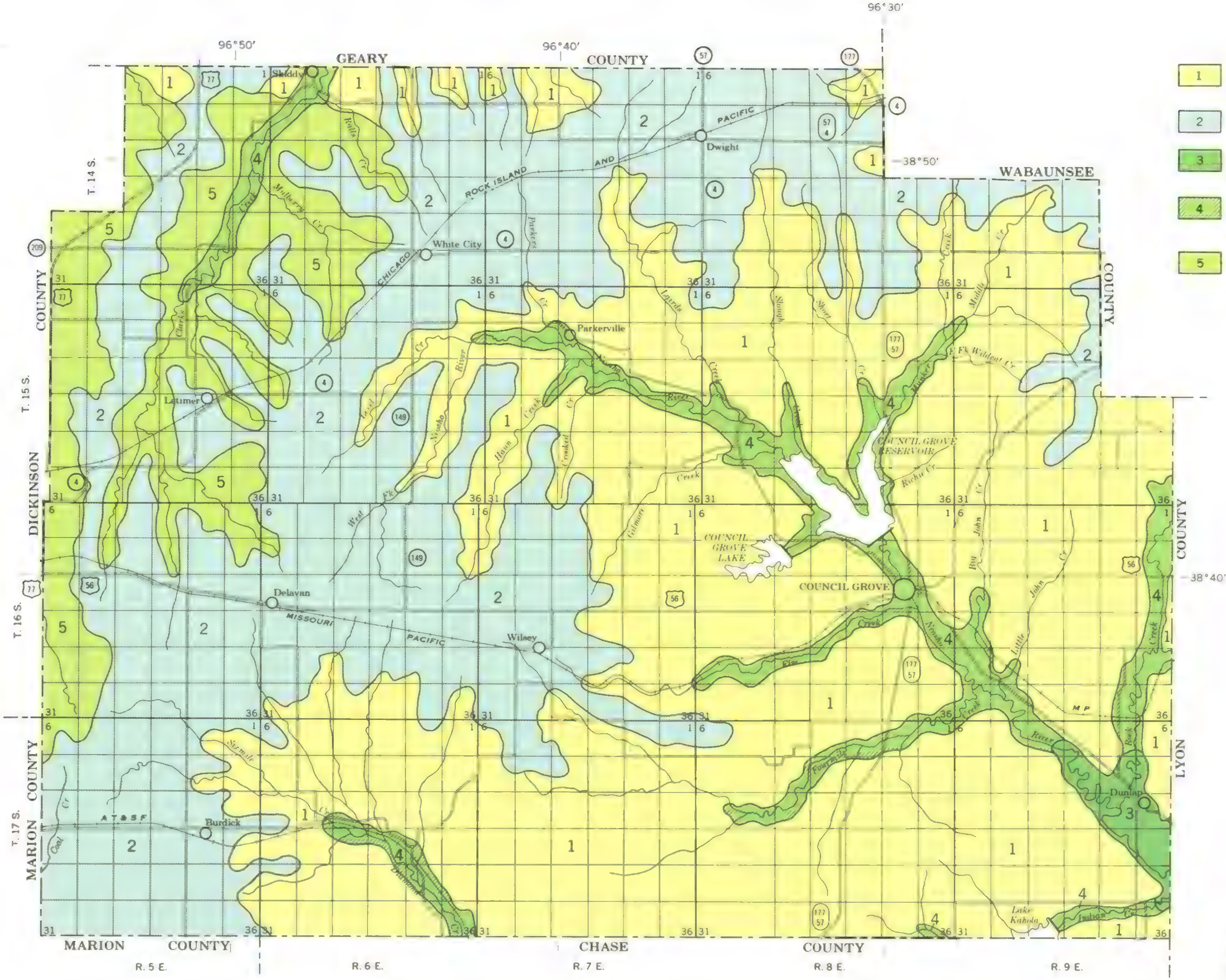


SOIL ASSOCIATIONS

1 Labette-Florence association: Moderately deep, gently sloping to sloping soils that have a clayey subsoil, and deep, sloping to moderately steep cherty soils that have a cherty clay subsoil; on uplands

2 Irwin-Ladysmith association: Deep, nearly level to sloping soils that have a clayey subsoil; on uplands

3 Chase-Mason-Reading association: Deep, nearly level soils that have a clayey and loamy subsoil; on stream terraces

4 Mason-Tully-Reading association: Deep, nearly level to sloping soils that have a loamy and clayey subsoil; on stream terraces and uplands

5 Irwin-Kipson-Sogn association: Deep, gently sloping and sloping soils that have a clayey subsoil, and shallow, gently sloping to moderately steep soils that are loamy throughout; on uplands

Compiled 1971

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
KANSAS AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

MORRIS COUNTY, KANSAS

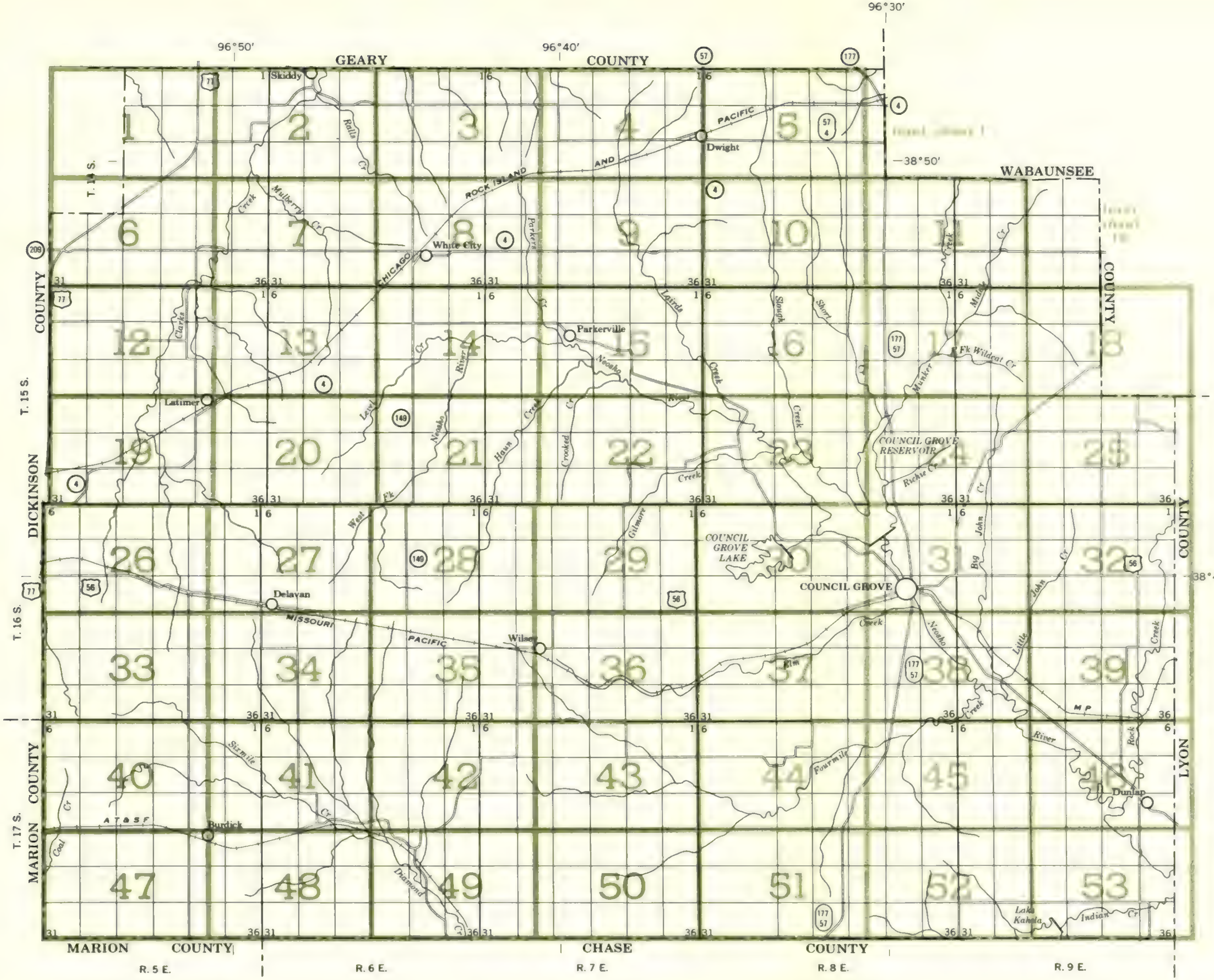
Scale 1 : 190,080

1 0 1 2 3 4 Miles

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



INDEX TO MAP SHEETS
MORRIS COUNTY, KANSAS

Scale 1:190,080

1 0 1 2 3 4 Miles

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads
- Divided
- Good motor
- Poor motor
- Trail

Highway markers
- National Interstate
- U. S.
- State or county

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail
- Railroad
- Ferry (FY)
- Ford (FORD)
- Grade
- R. R. over
- R. R. under

Buildings
- School
- Church

Mine and quarry

Gravel pit

Power line

Pipeline

Cemetery

Dams

Levee

Tanks

Well, oil or gas

Forest fire or lookout station

Windmill

Located object

BOUNDARIES

- National or state
- County
- Minor civil division
- Reservation
- Land grant
- Small park, cemetery, airport
- Land survey division corners

DRAINAGE

Streams, double-line
- Perennial
- Intermittent

Streams, single-line
- Perennial
- Intermittent
  - Crossable with tillage implements
  - Not crossable with tillage implements
  - Unclassified

Canals and ditches

Lakes and ponds
- Perennial (water, w)
- Intermittent (int)

Spring

Marsh or swamp

Wet spot

Drainage end or alluvial fan

RELIEF

Escarpments
- Bedrock
- Other

Short steep slope

Prominent peak

Depressions (Large, Small)
- Crossable with tillage implements
- Not crossable with tillage implements
- Contains water most of the time

SOIL SURVEY DATA

Soil boundary and symbol (Dx)

Gravel

Stoniness
- Stony
- Very stony

Rock outcrops

Chert fragments

Clay spot

Sand spot

Gumbo or scabby spot

Made land

Severely eroded spot

Blowout, wind erosion

Gully

Limy area, up to 3 acres

Cherty soil area, up to 2 acres

SOIL LEGEND

SYMBOL	NAME
Ar	Alluvial land and Reading soils
Ch	Chase silty clay loam
Cs	Clime-Sogn complex, 5 to 20 percent slopes
Dh	Dwight silt loam, 1 to 3 percent slopes
Fc	Florence cherty silt loam, 5 to 15 percent slopes
Fe	Florence-Labette complex, 2 to 12 percent slopes
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Os	Osage silty clay
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Sm	Smolan silt loam, 1 to 3 percent slopes
Sn	Smolan silty clay loam, 2 to 6 percent slopes, eroded
Ts	Tully silty clay loam, 3 to 7 percent slopes
Tt	Tully silty clay loam, 3 to 7 percent slopes, eroded
Ty	Tully soils, 5 to 15 percent slopes

MORRIS COUNTY, KANSAS — SHEET NUMBER 1

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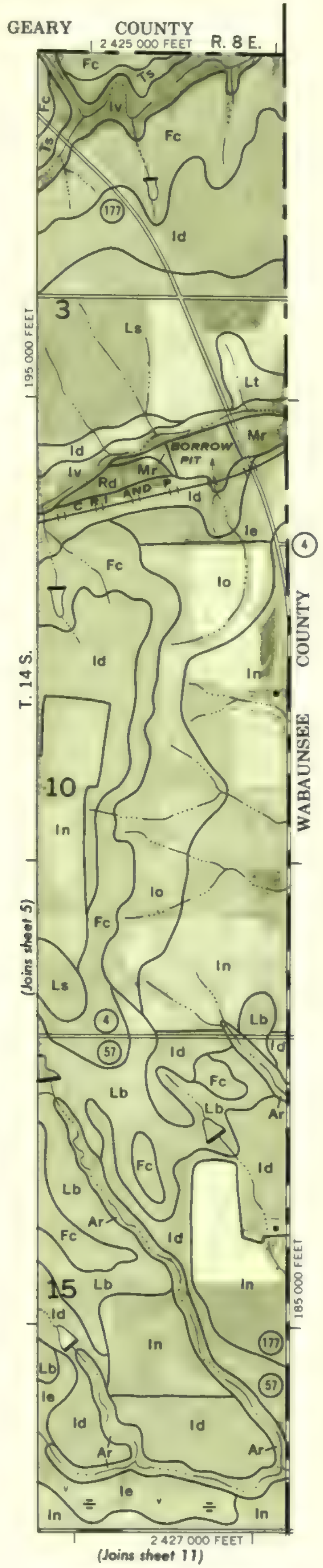
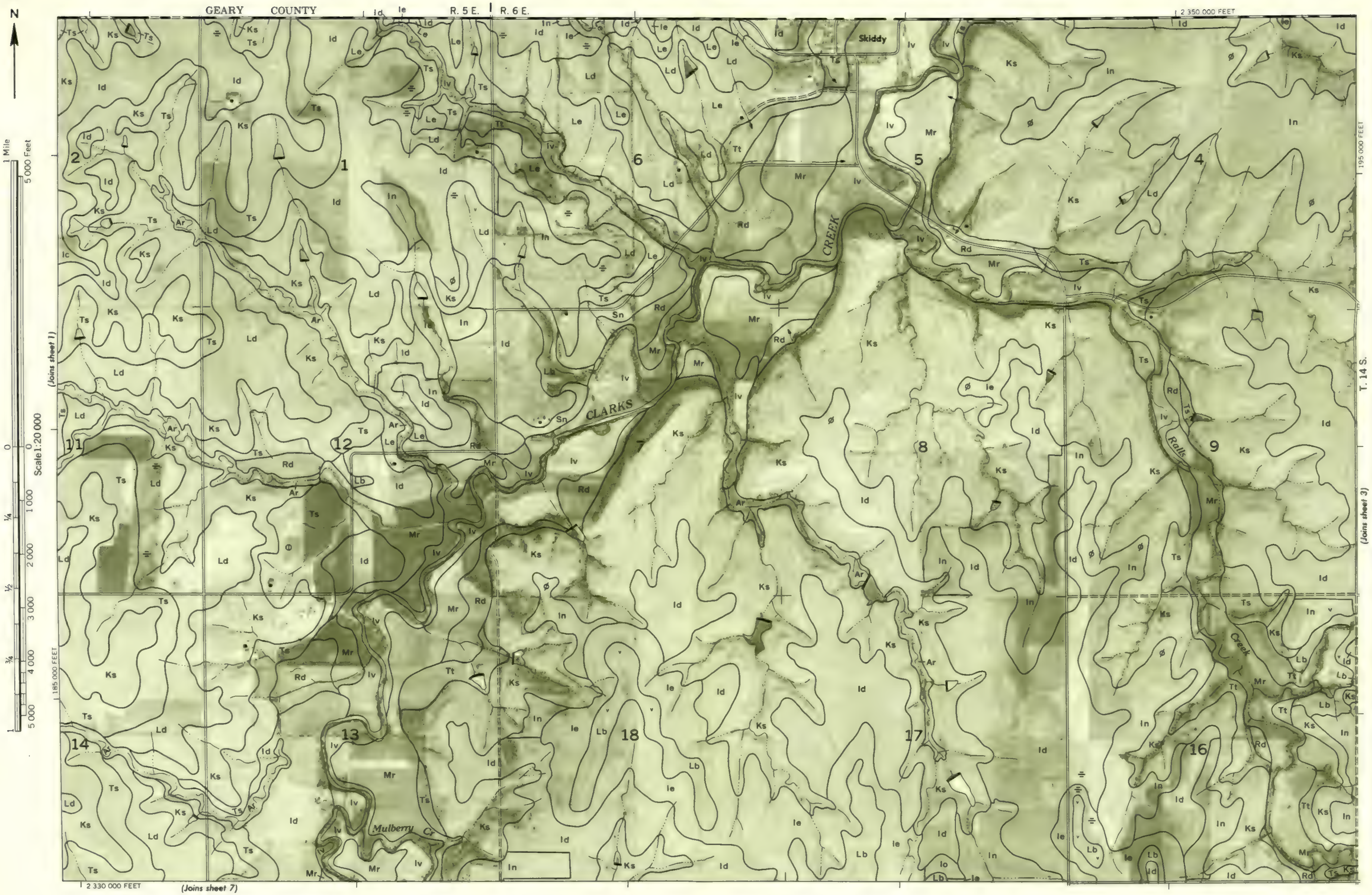
Land division corners are approximately positioned on this map.



2 000 AND 5 000-FOOT GRID TICKS

2

MORRIS COUNTY, KANSAS — SHEET NUMBER 2



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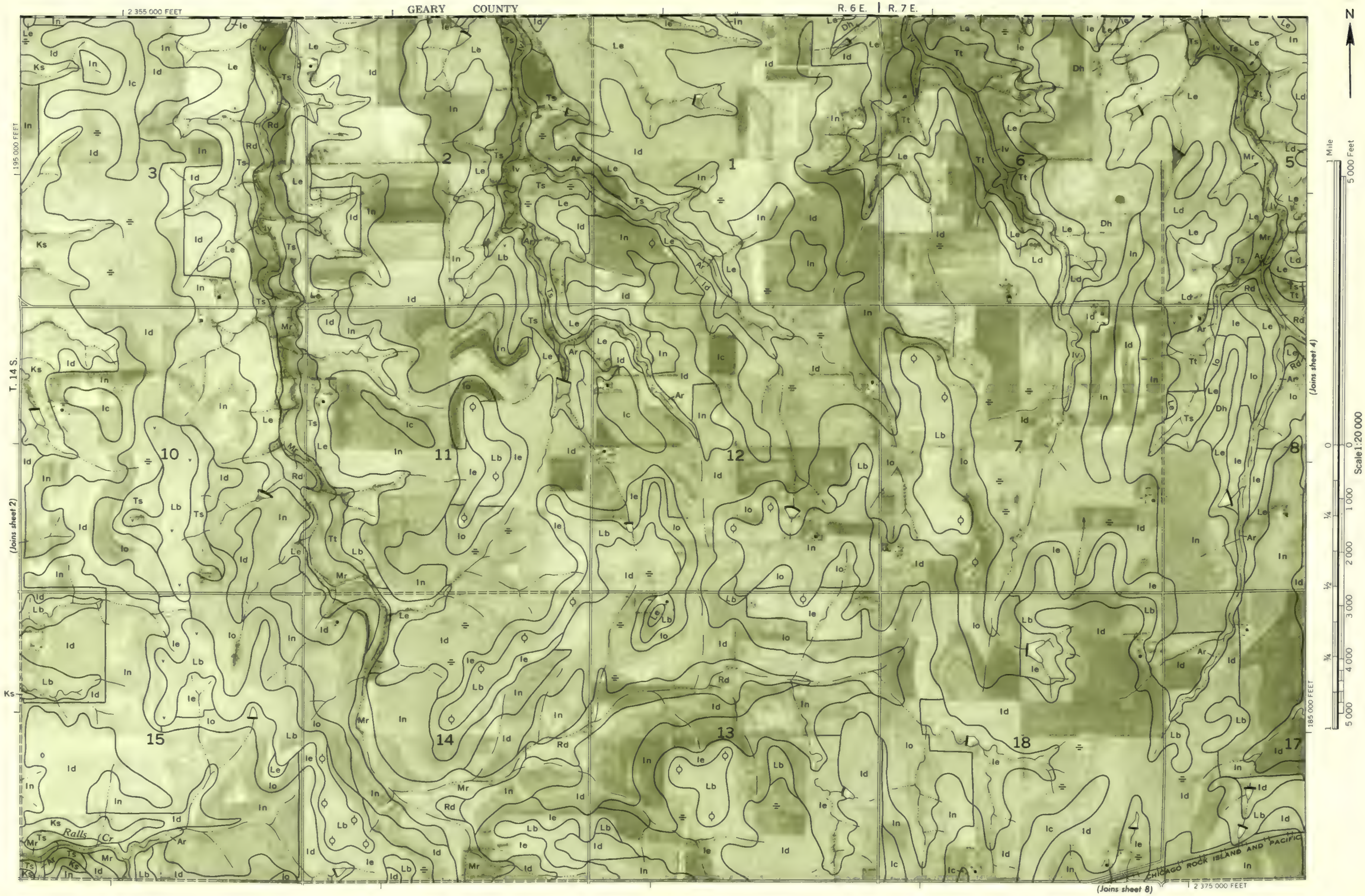

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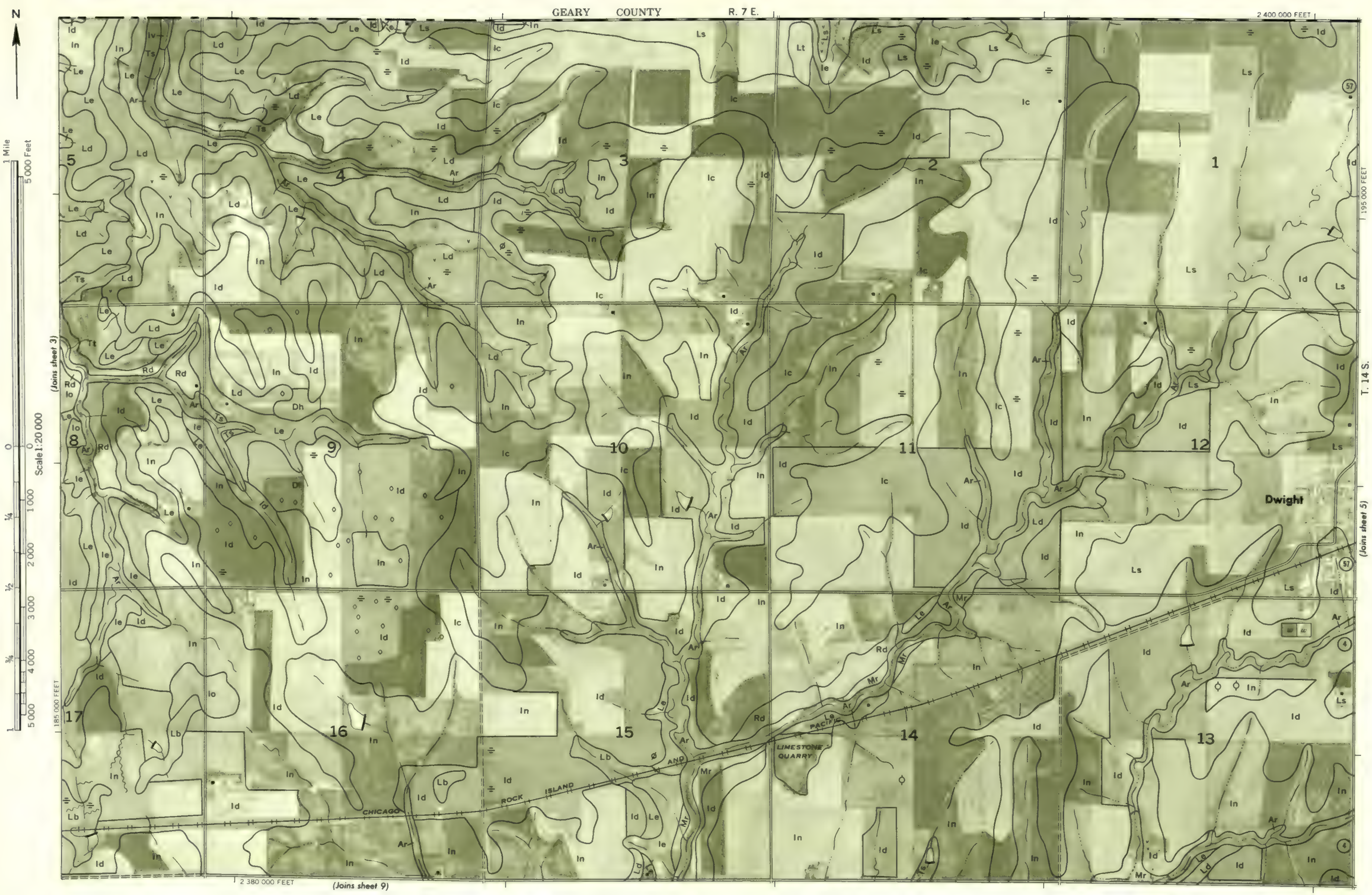

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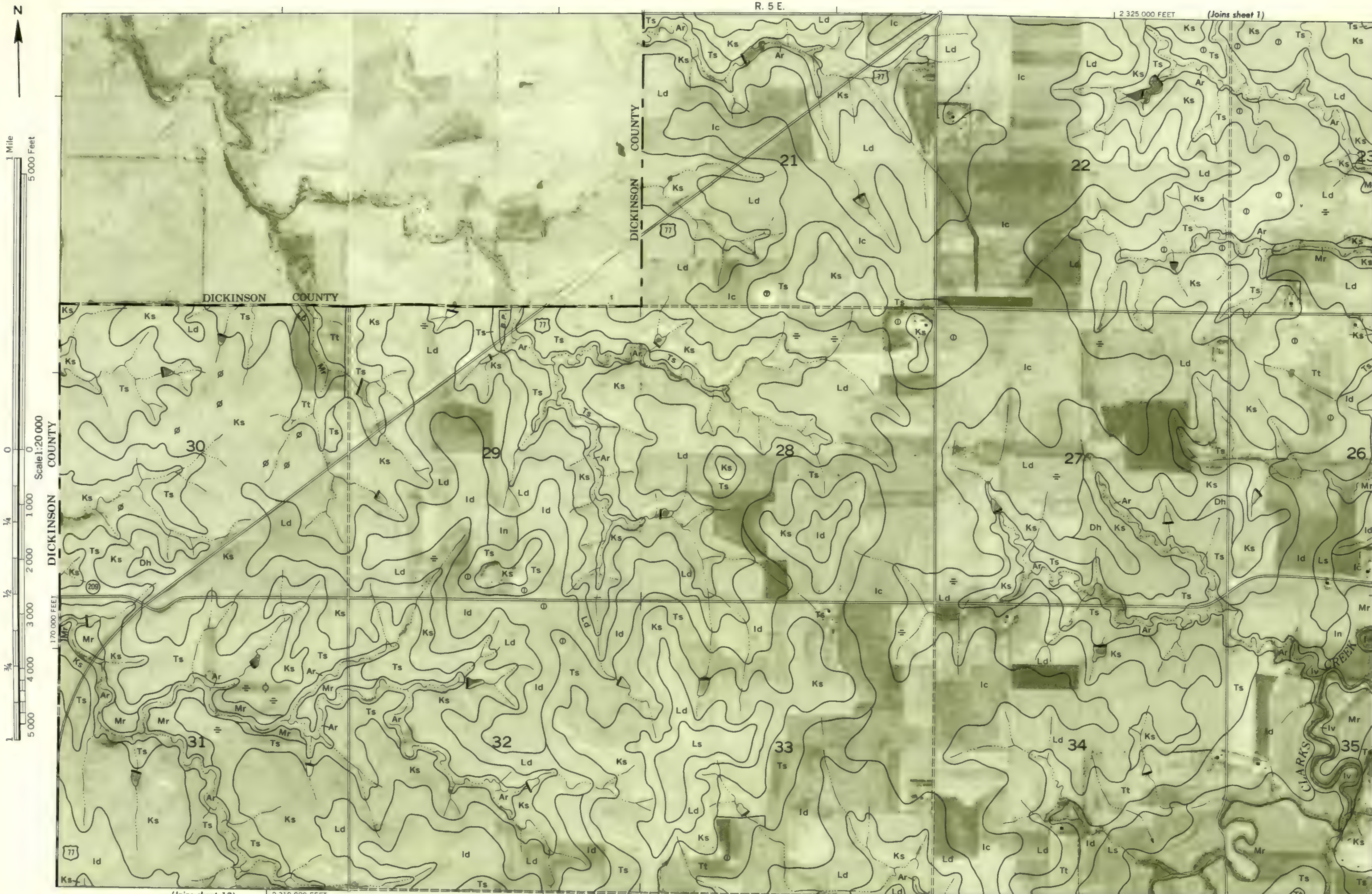

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MORRIS COUNTY, KANSAS NO. 6

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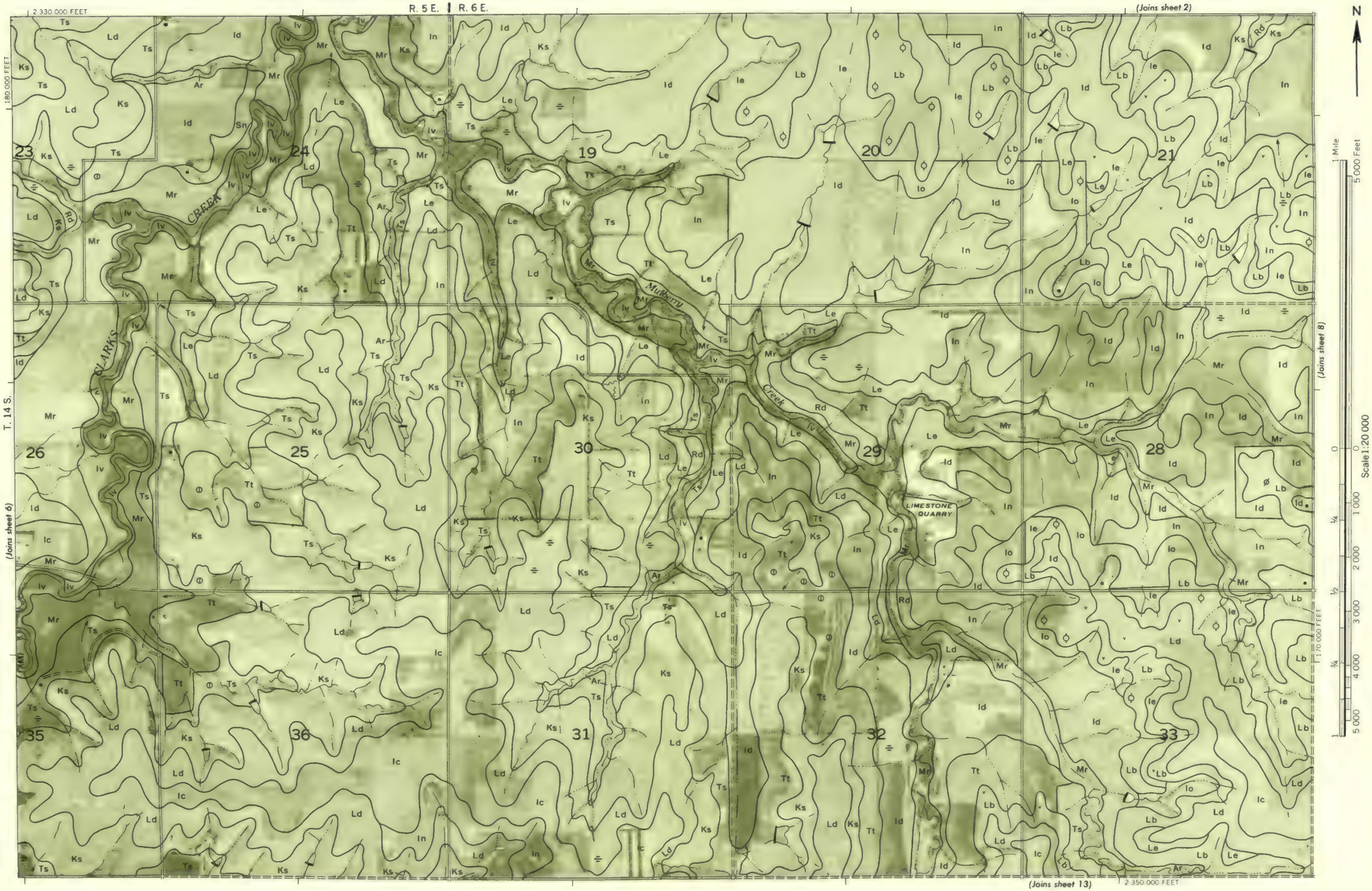

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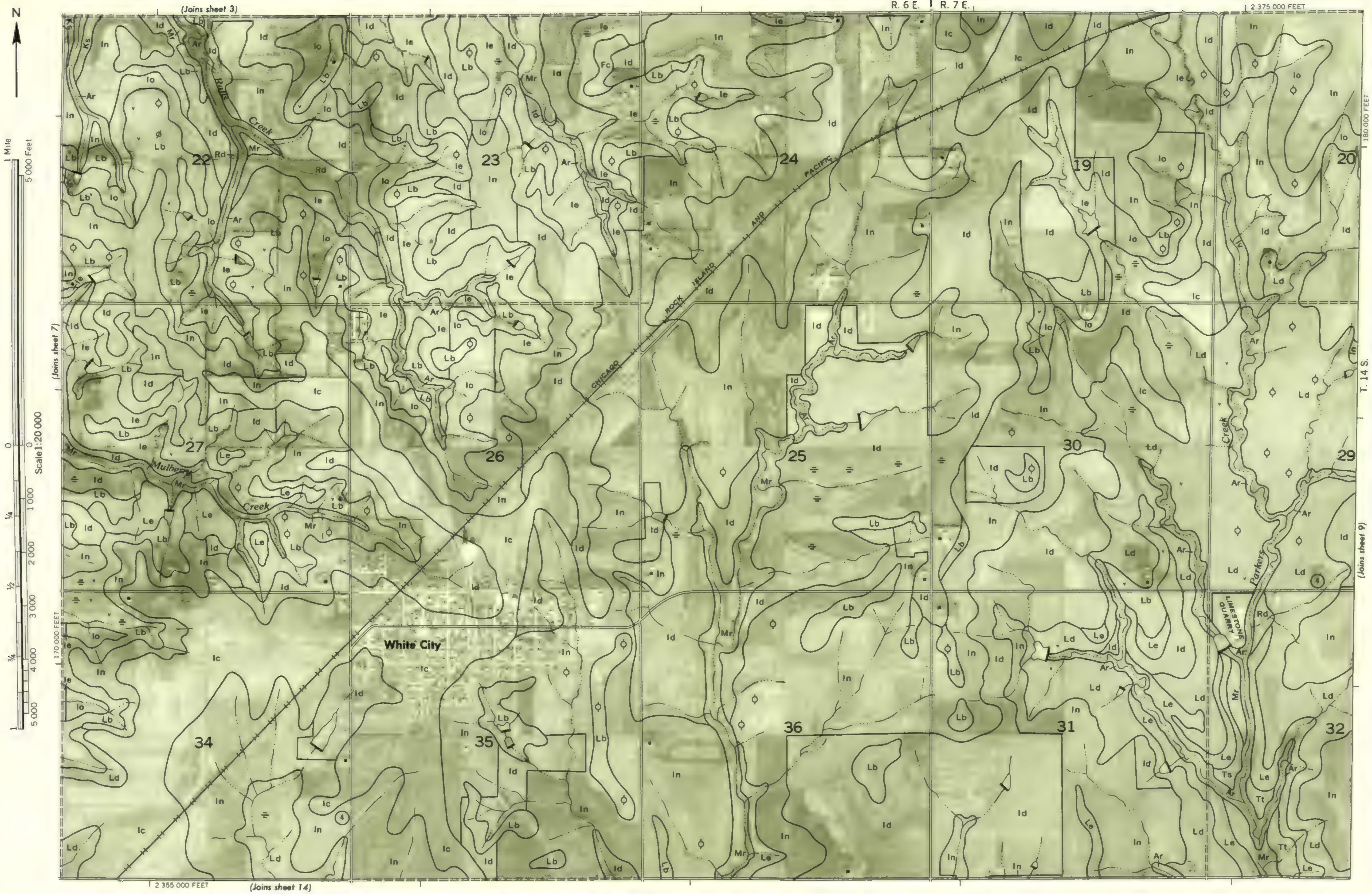

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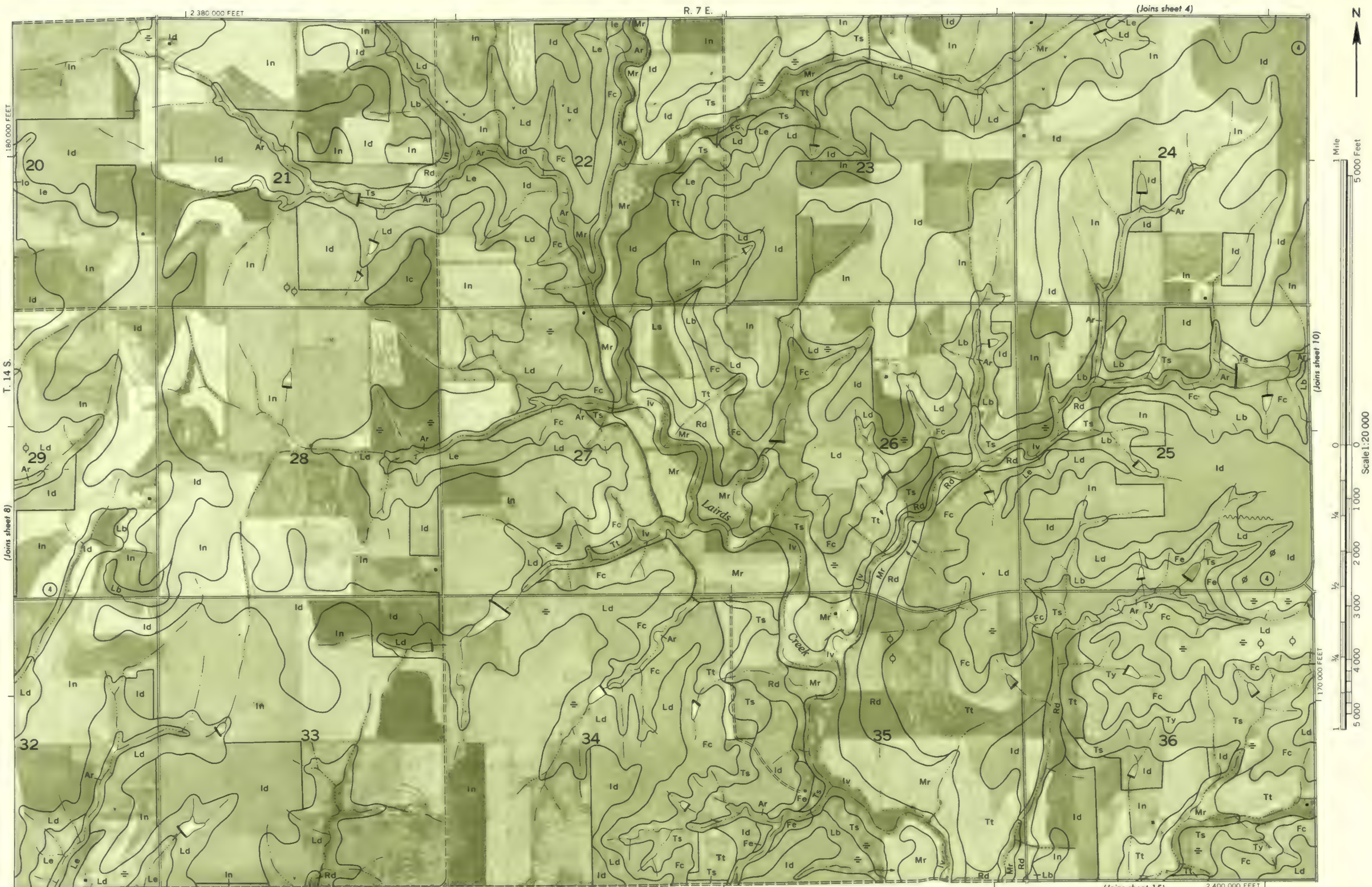

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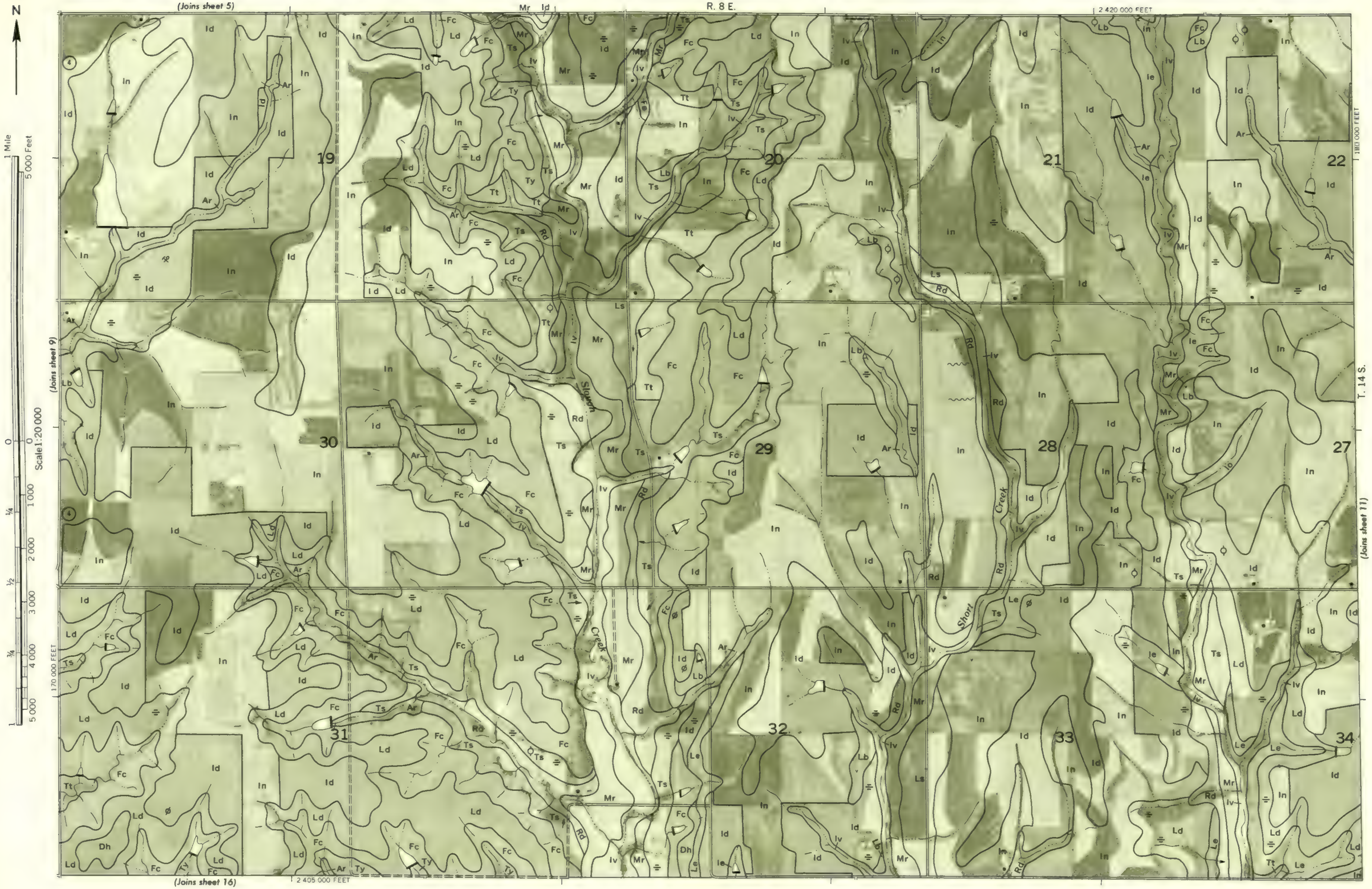

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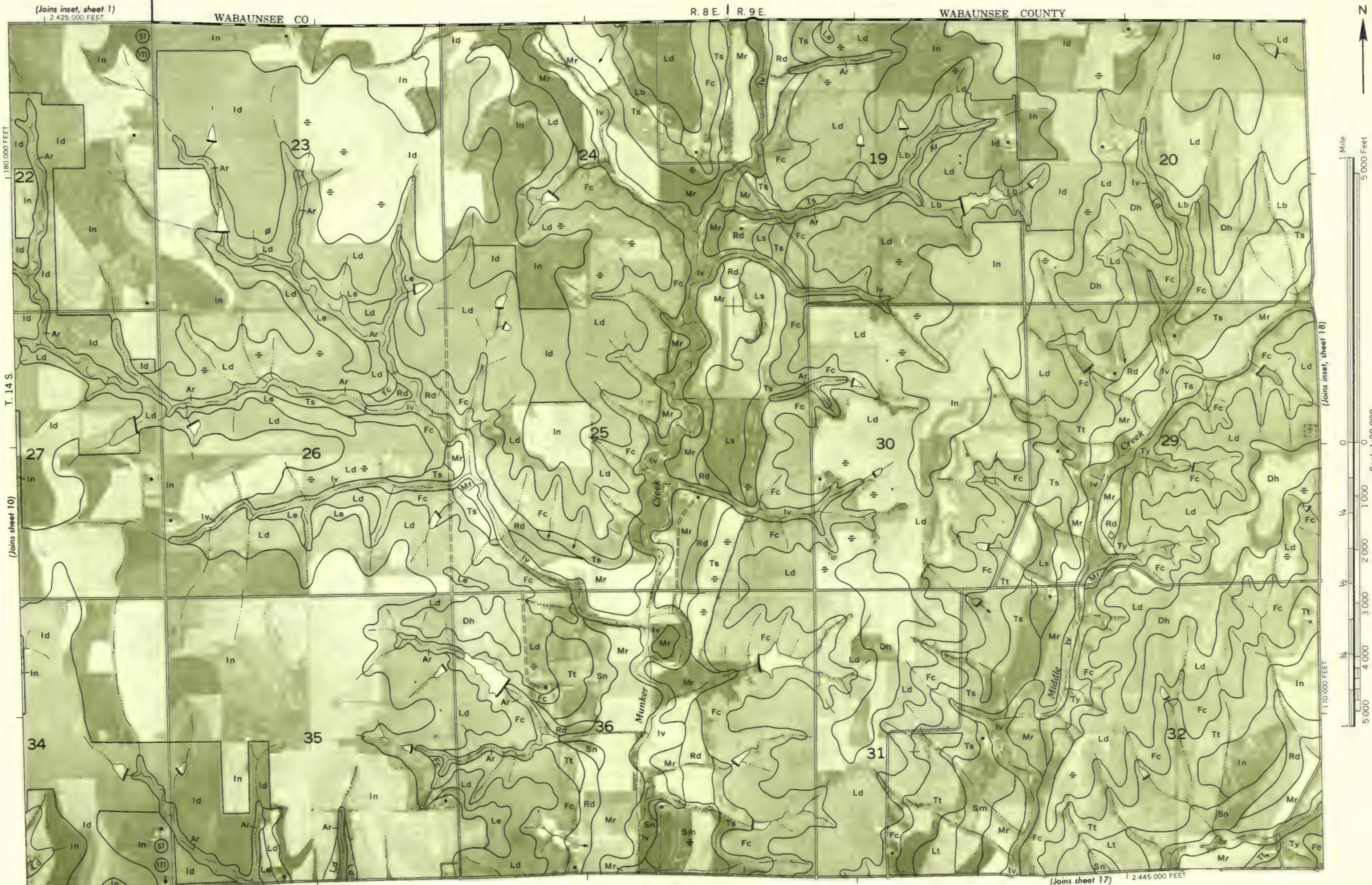

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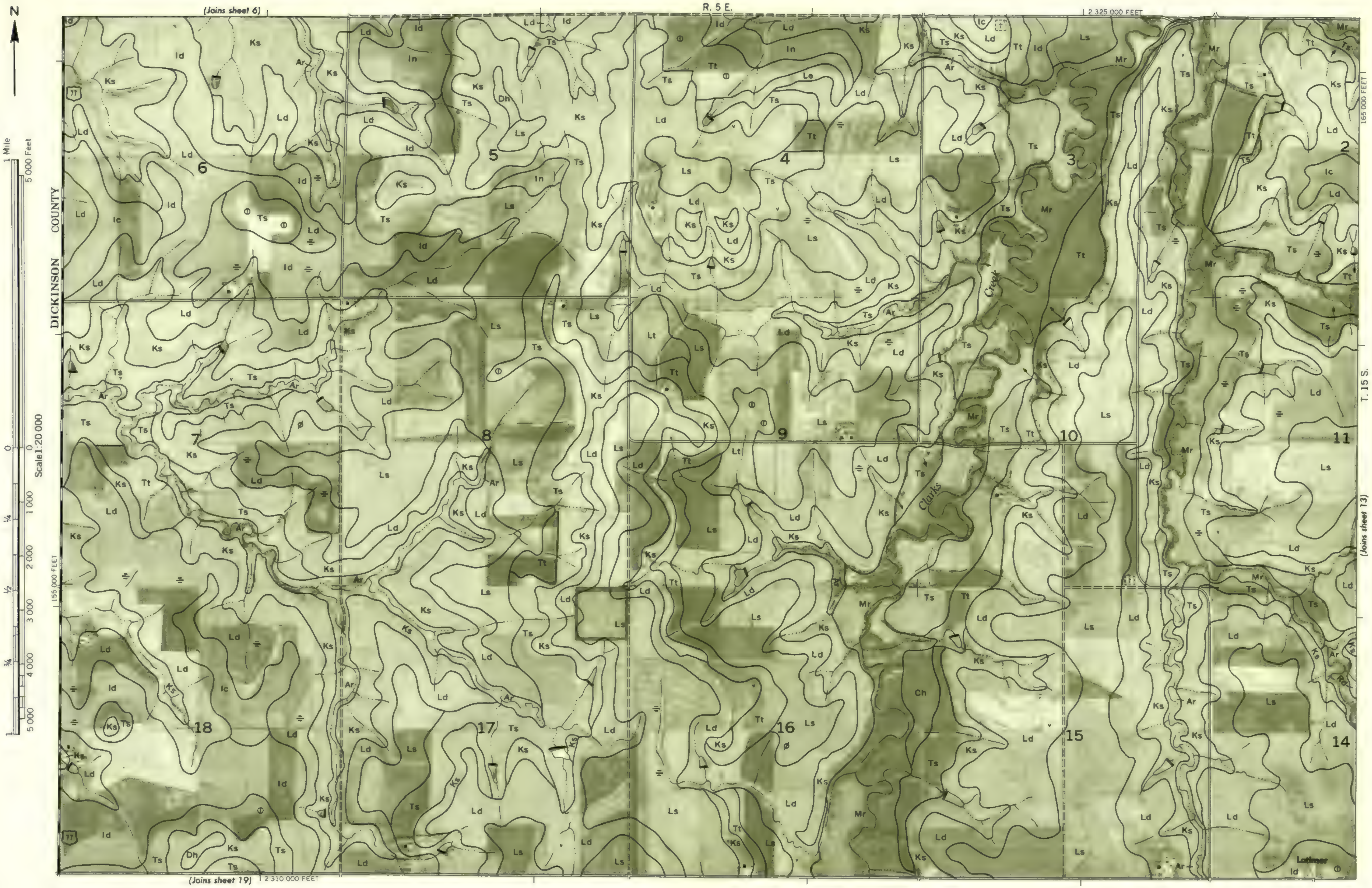

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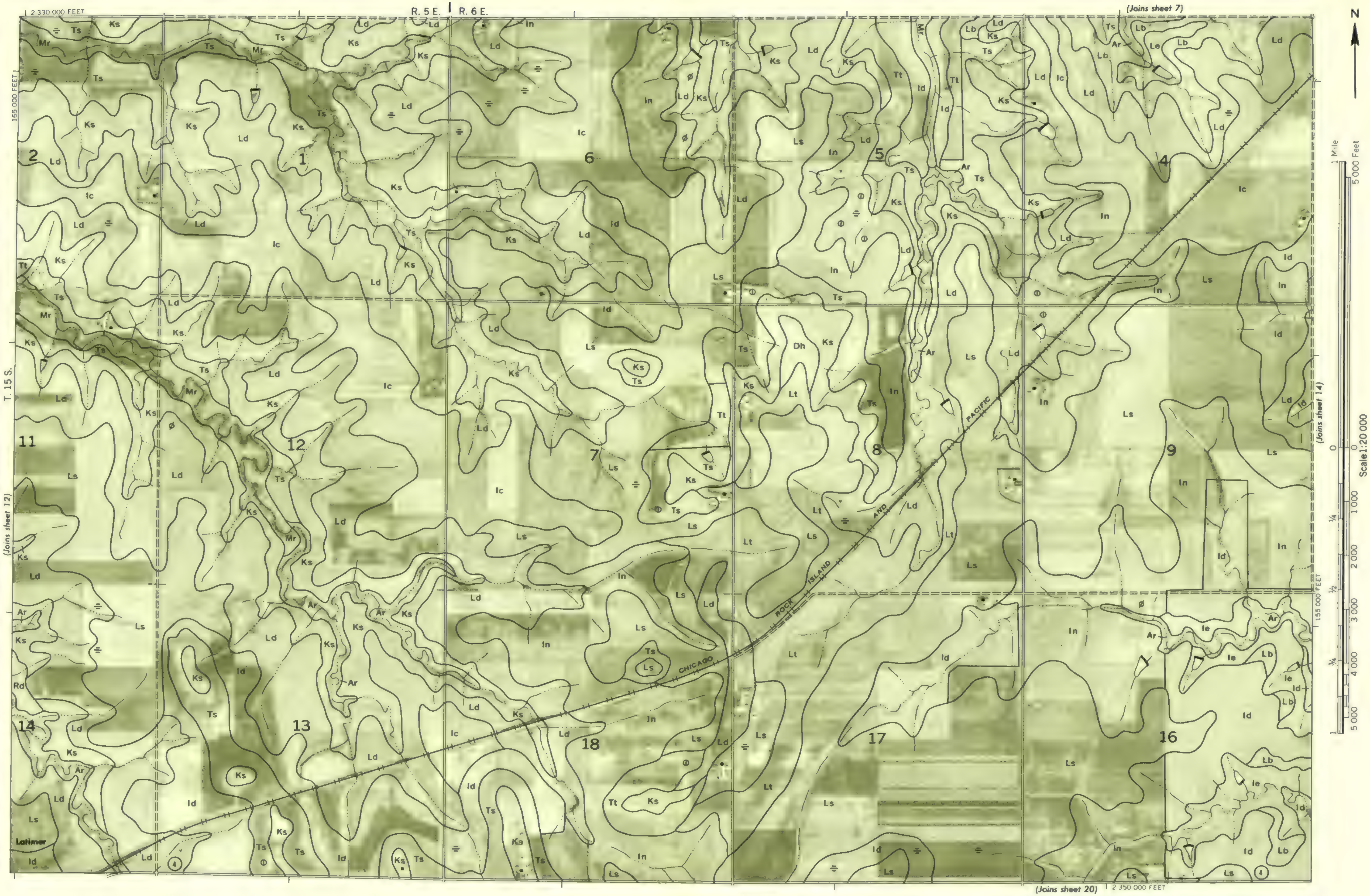

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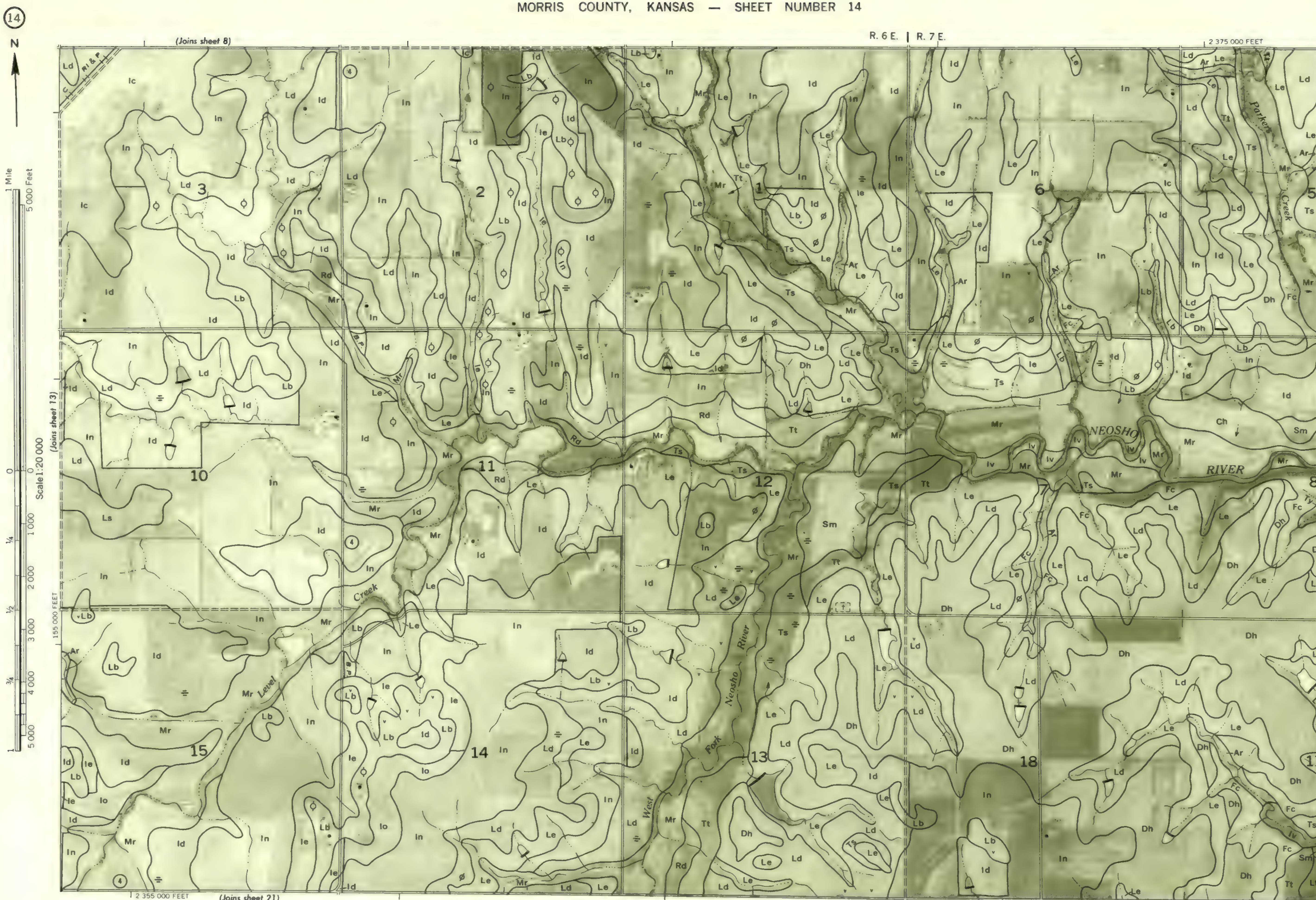

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MORRIS COUNTY, KANSAS NO. 14

MORRIS COUNTY, KANSAS — SHEET NUMBER 15

(15)

MORRIS COUNTY, KANSAS NO. 15

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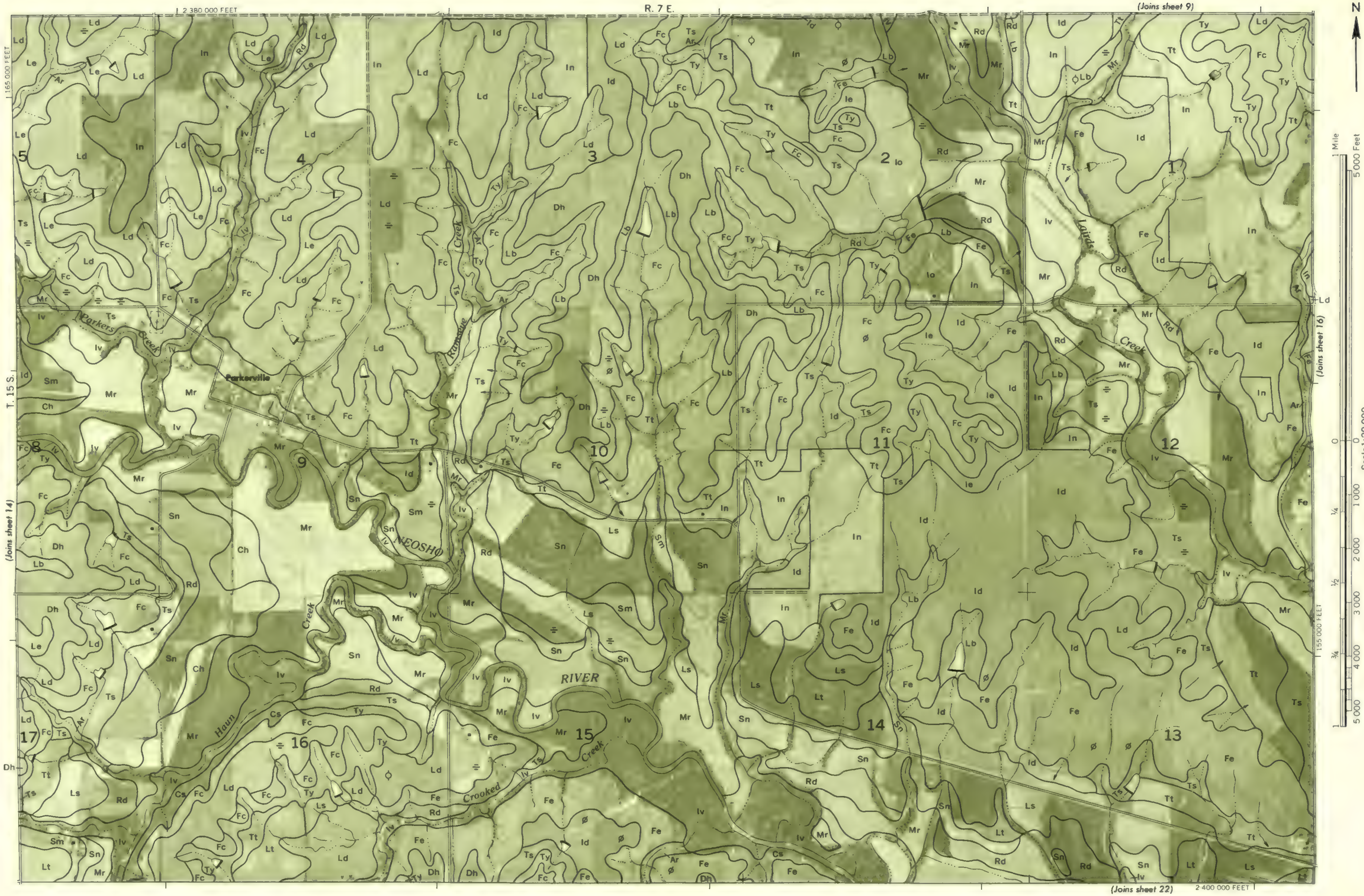

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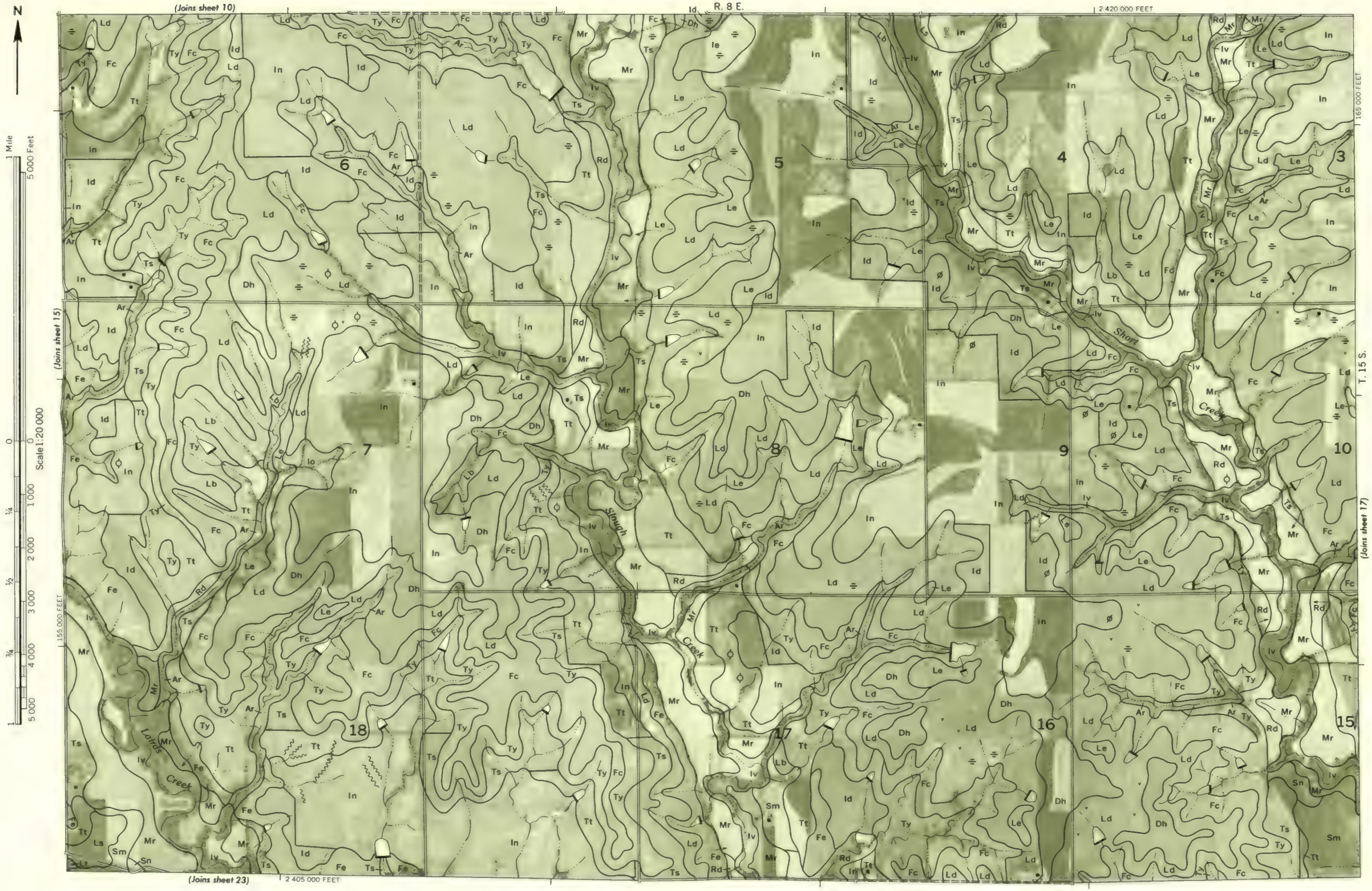

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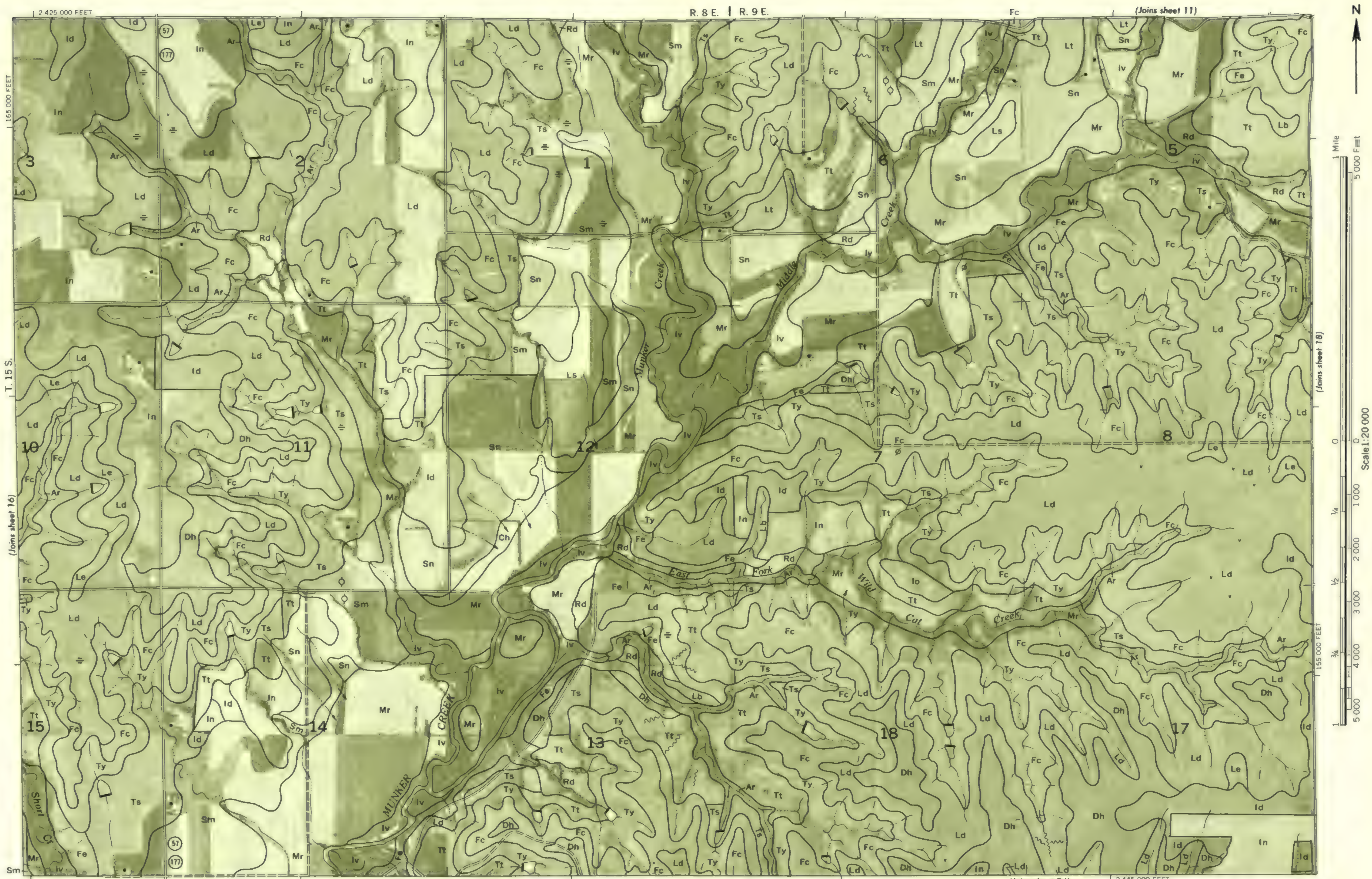

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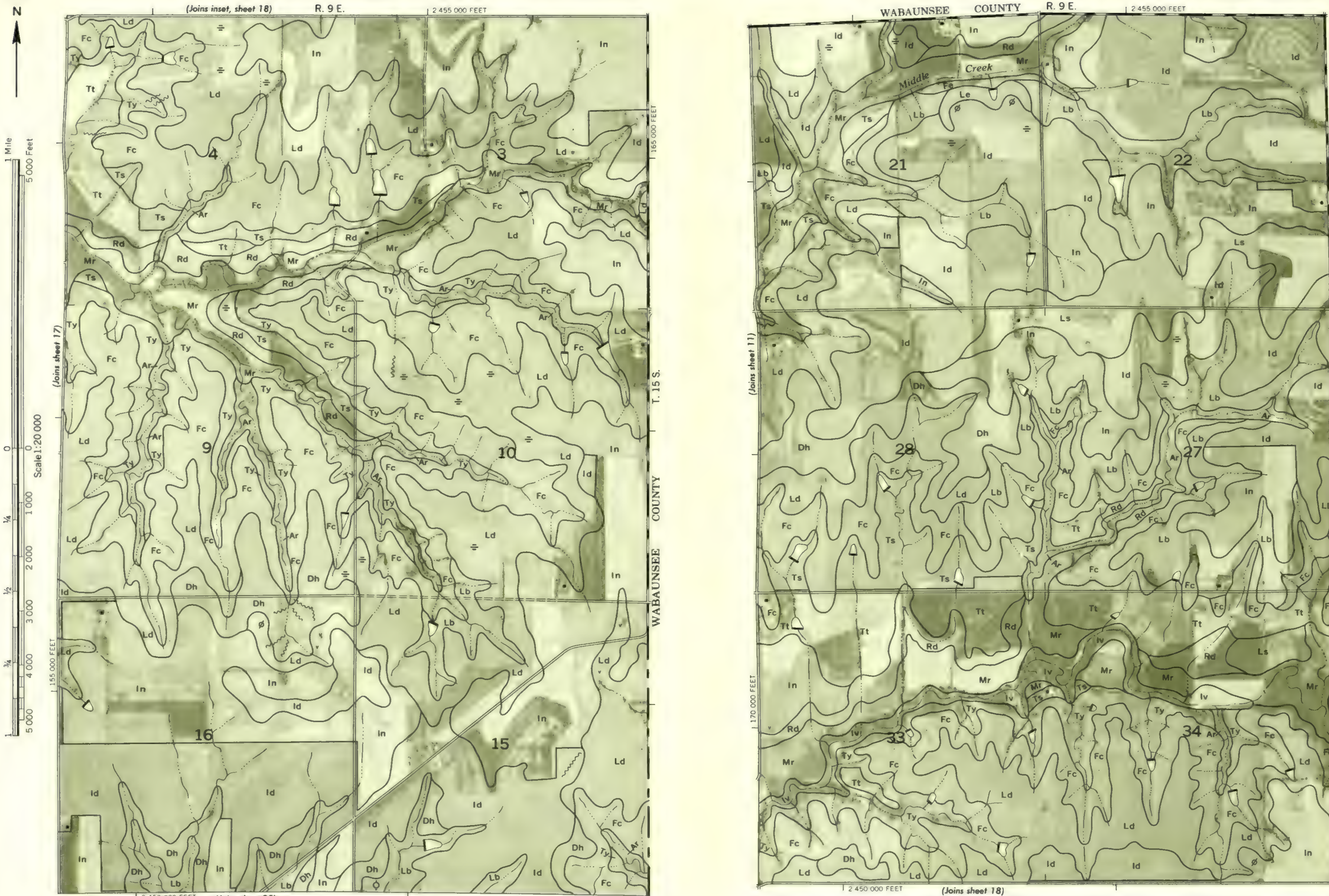

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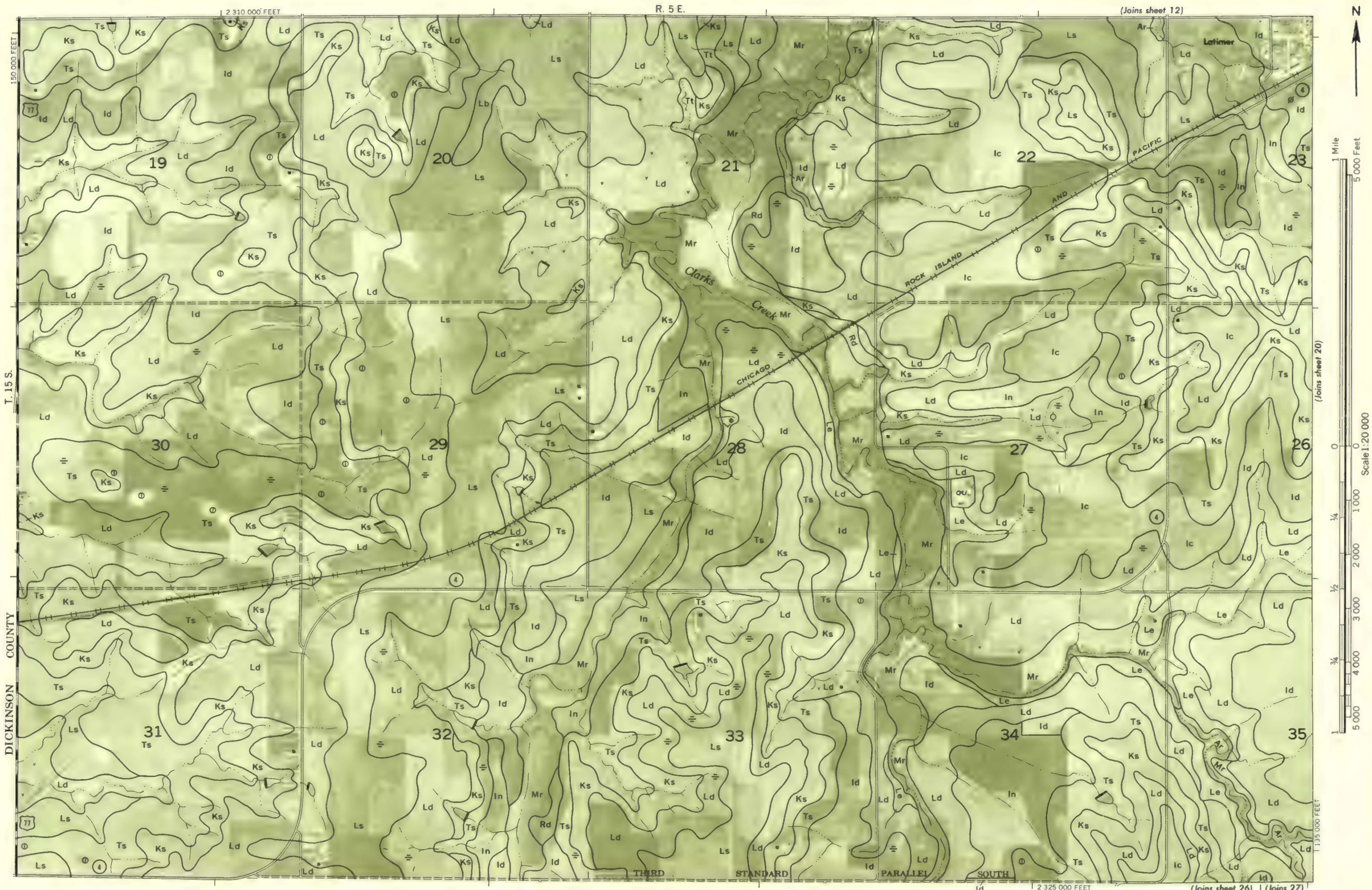

MORRIS COUNTY, KANSAS NO. 19

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Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, north zone.
Land division corners are approximately positioned on this map.

MORRIS COUNTY, KANSAS — SHEET NUMBER 20

Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, north zone.

This map is one of a set compiled in 1971 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.

MORRIS COUNTY, KANSAS NO. 20

MORRIS COUNTY, KANSAS NO. 21
This map is one of a set compiled in 1971 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, north zone.
Land division corners are approximately positioned on this map.

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Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, north zone.

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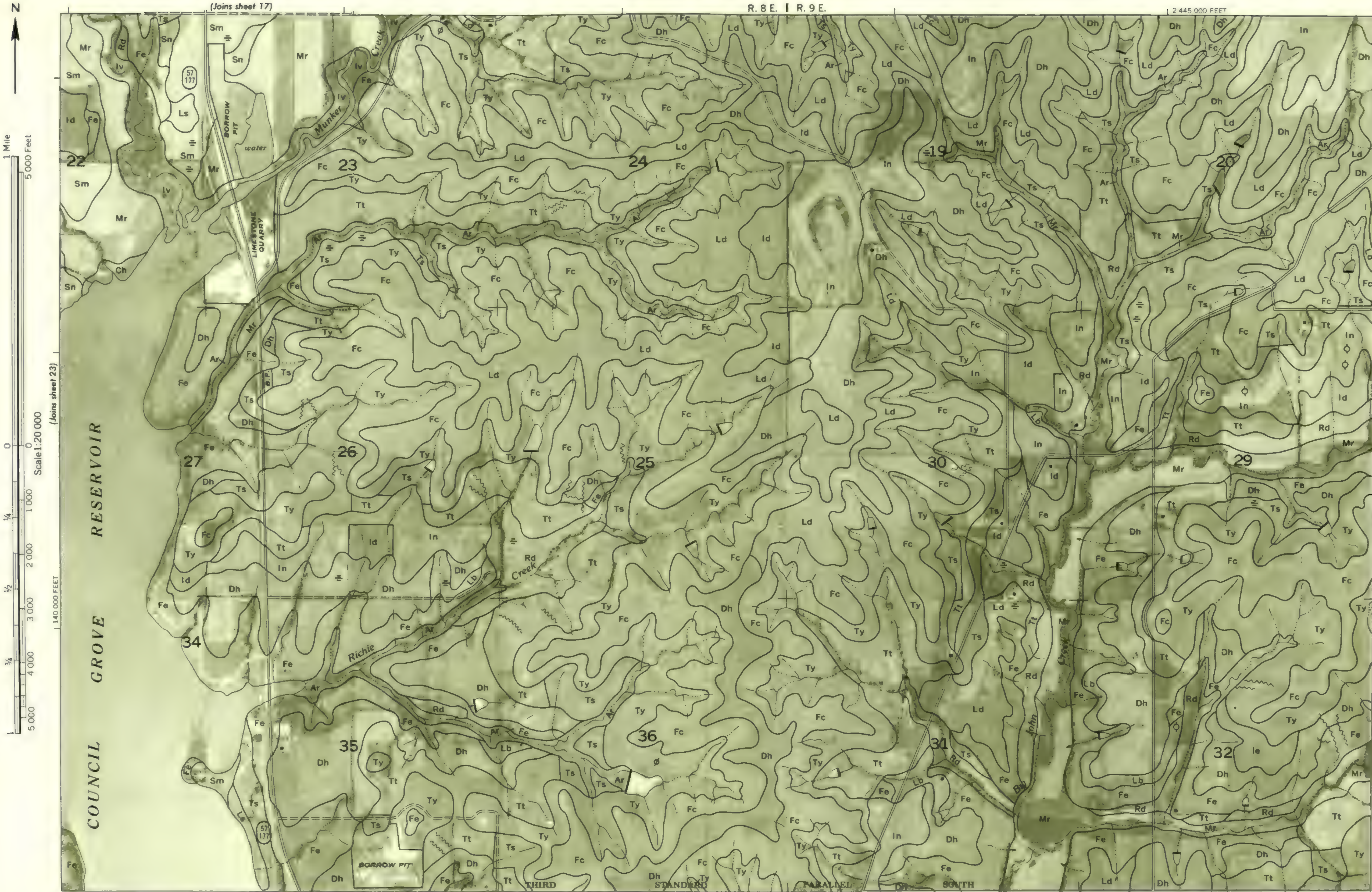
MORRIS COUNTY, KANSAS NO. 23

This map is one of a set compiled in 1971 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, north zone.
Land division corners are approximately positioned on this map.

MORRIS COUNTY, KANSAS — SHEET NUMBER 24



Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, north zone.

This map is one of a set compiled in 1971 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.

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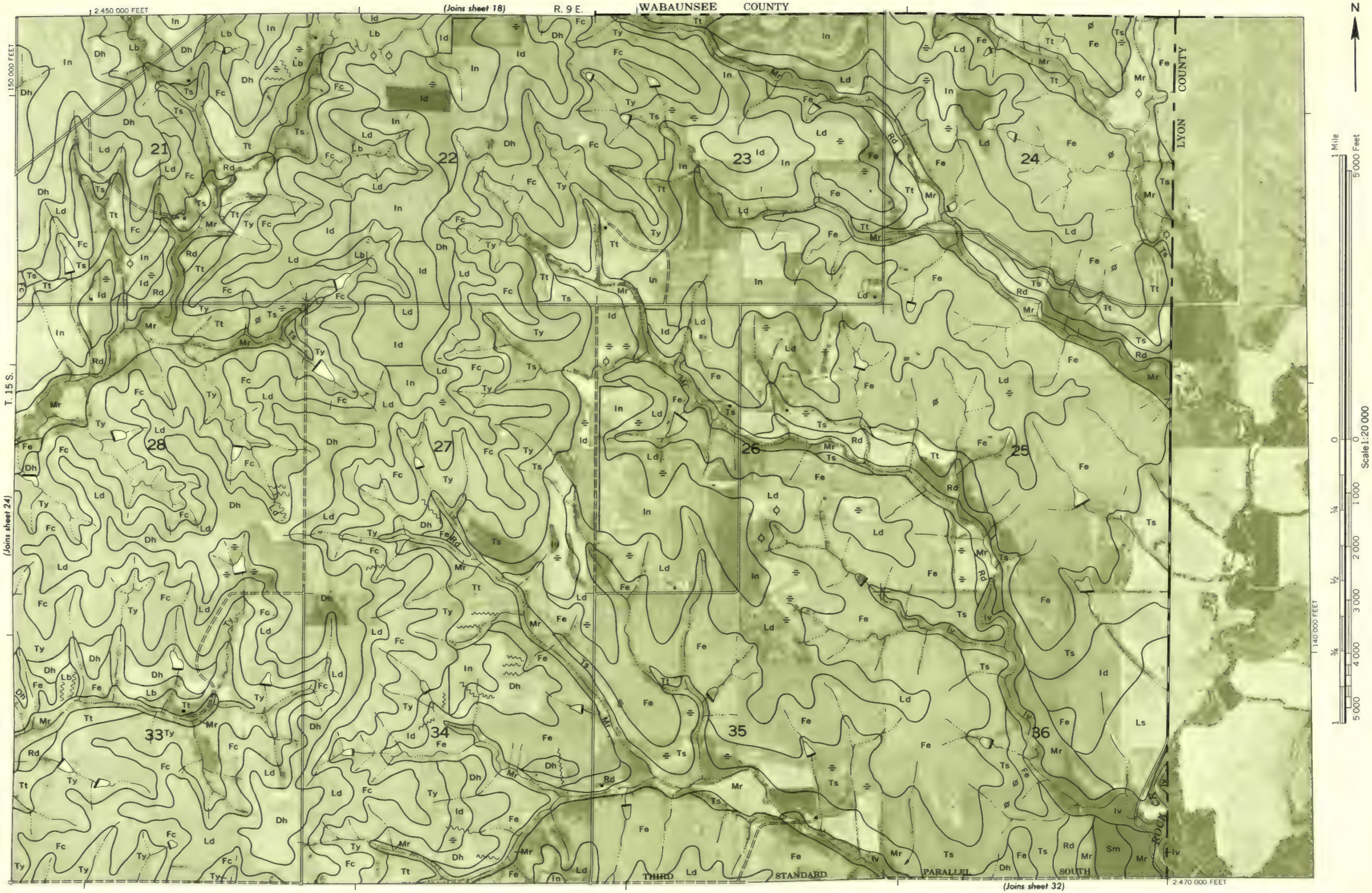
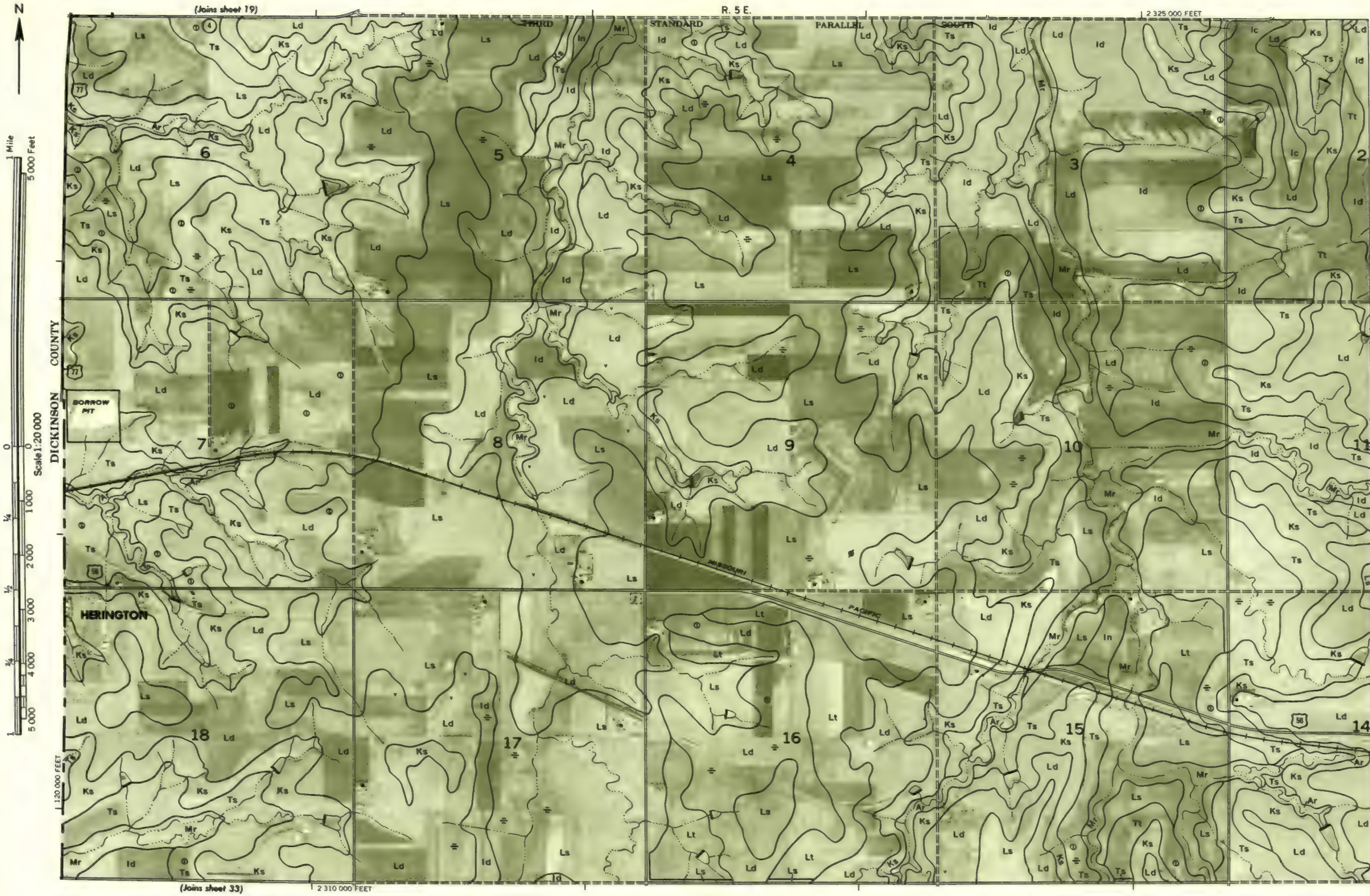
Land division corners are approximately positioned on this map.



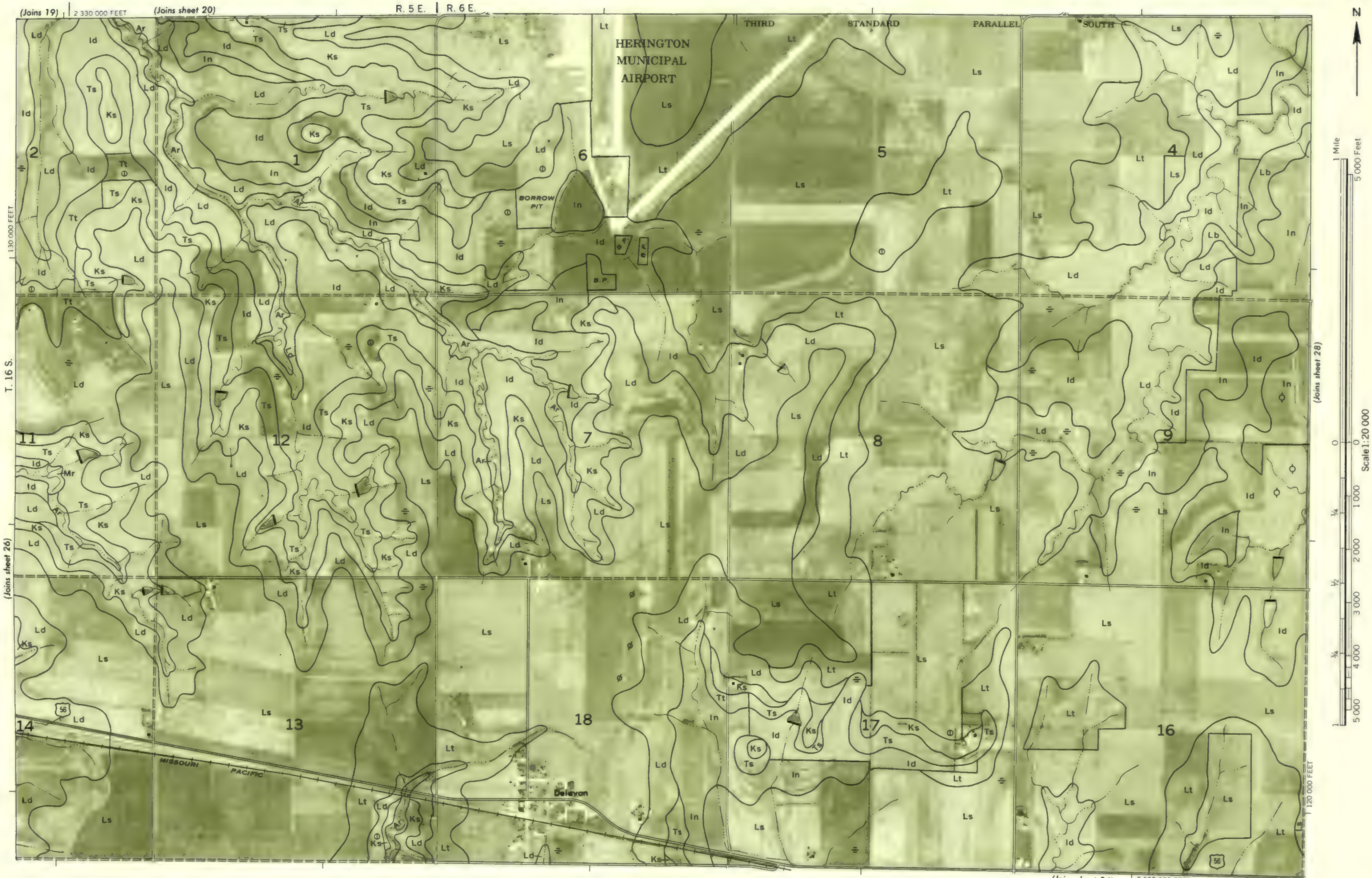
MORRIS COUNTY, KANSAS — SHEET NUMBER 26



Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, north zone.

This map is one of a set compiled in 1971 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.



MORRIS COUNTY, KANSAS NO. 27

This map is one of a set compiled in 1971 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, north zone.

Land division corners are approximately positioned on this map.

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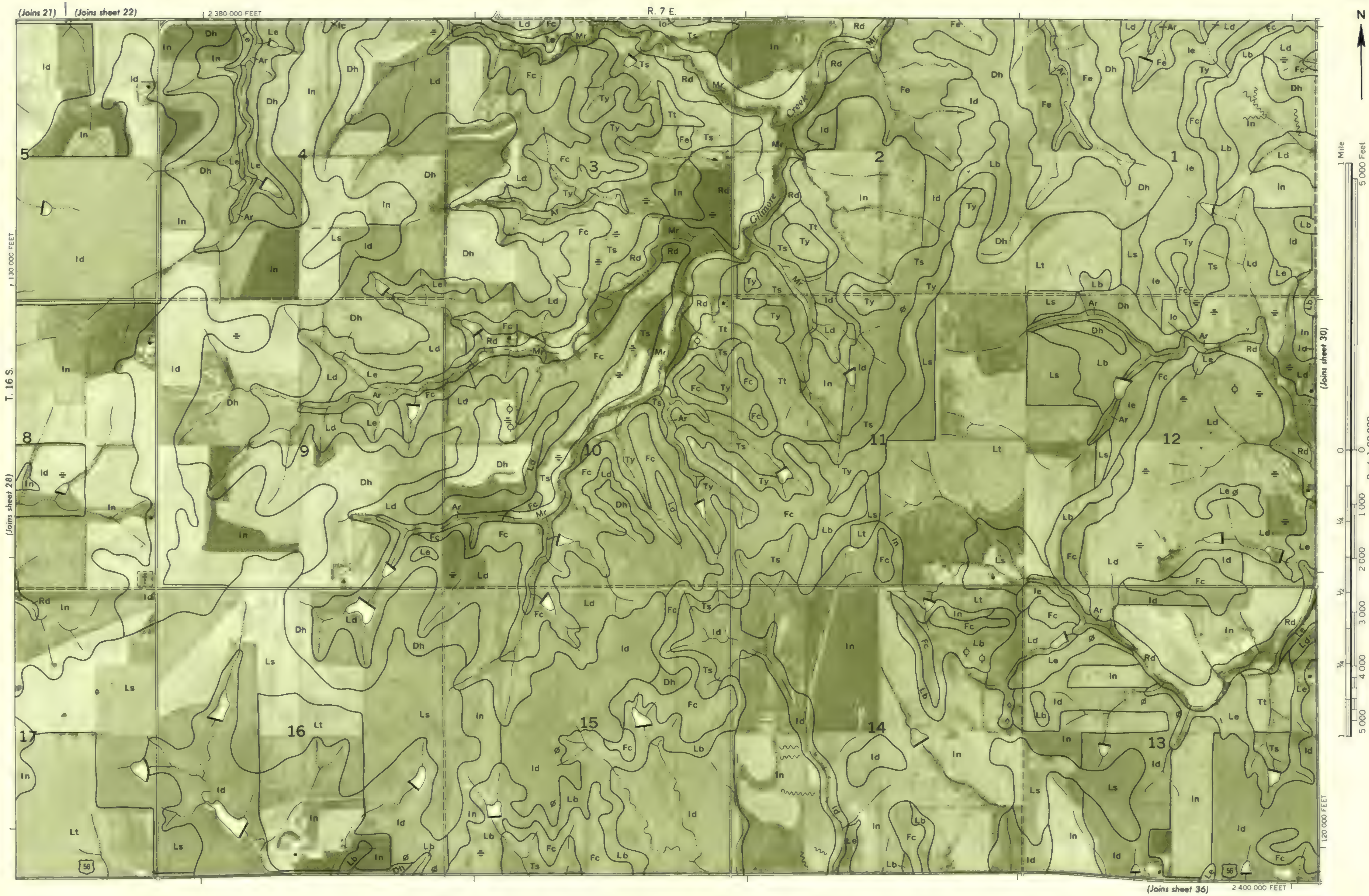
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, north zone

This map is one of a set compiled in 1971 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station

MORRIS COUNTY, KANSAS NO. 28



MORRIS COUNTY, KANSAS NO. 29

This map is one of a set compiled in 1971 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station. Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, north zone. Land division corners are approximately positioned on this map.

Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, north zone.

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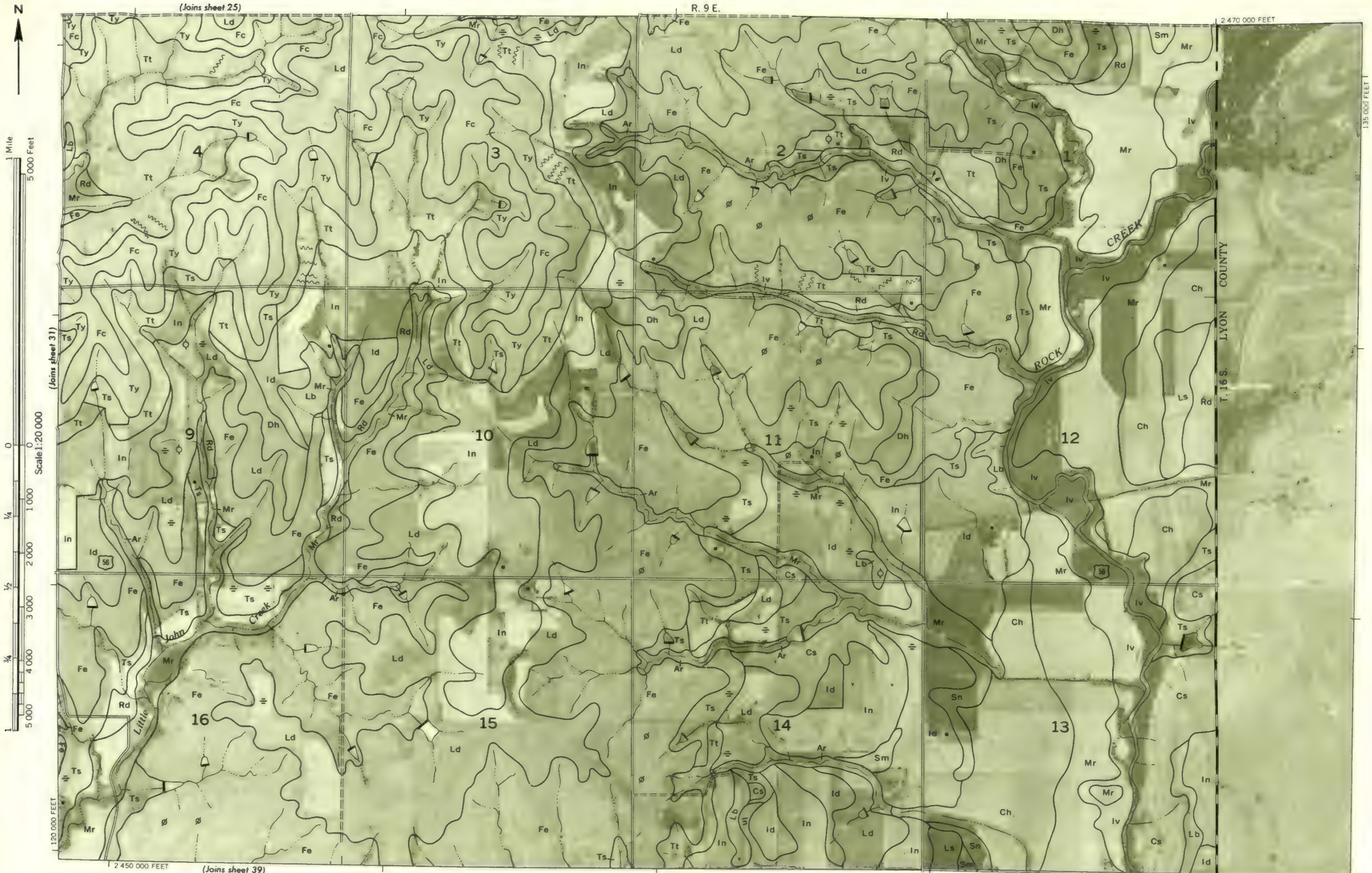
MORRIS COUNTY, KANSAS NO. 31

This map is one of a set compiled in 1971 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, north zone

Land division corners are approximately positioned on this map.

MORRIS COUNTY, KANSAS — SHEET NUMBER 32



Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, north zone

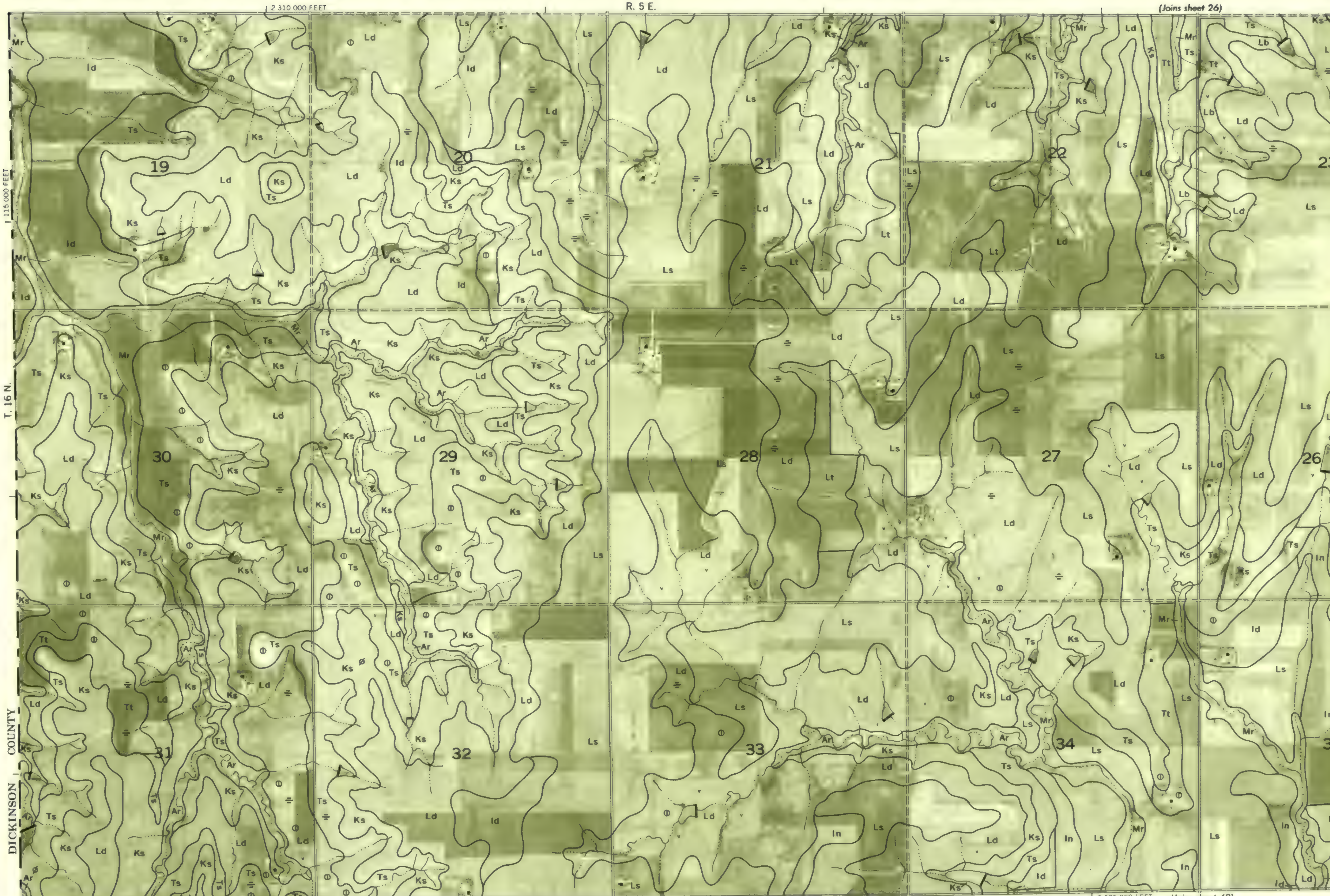
This map is one of a set compiled in 1971 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station

33

N

MORRIS COUNTY, KANSAS NO. 33

This map is one of a set compiled in 1971 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, north zone.
Land division corners are approximately positioned on this map.



1 Mile
5 000 Feet
0
1/4 1/2 3/4 1
0 1000 2000 3000 4000 5000
Scale 1:20 000

N

1 Mile 5 000 Feet

Scale 1:20 000

0 0 1/4 1 000 2 000 1/2 3 000 3/4 4 000 1 5 000

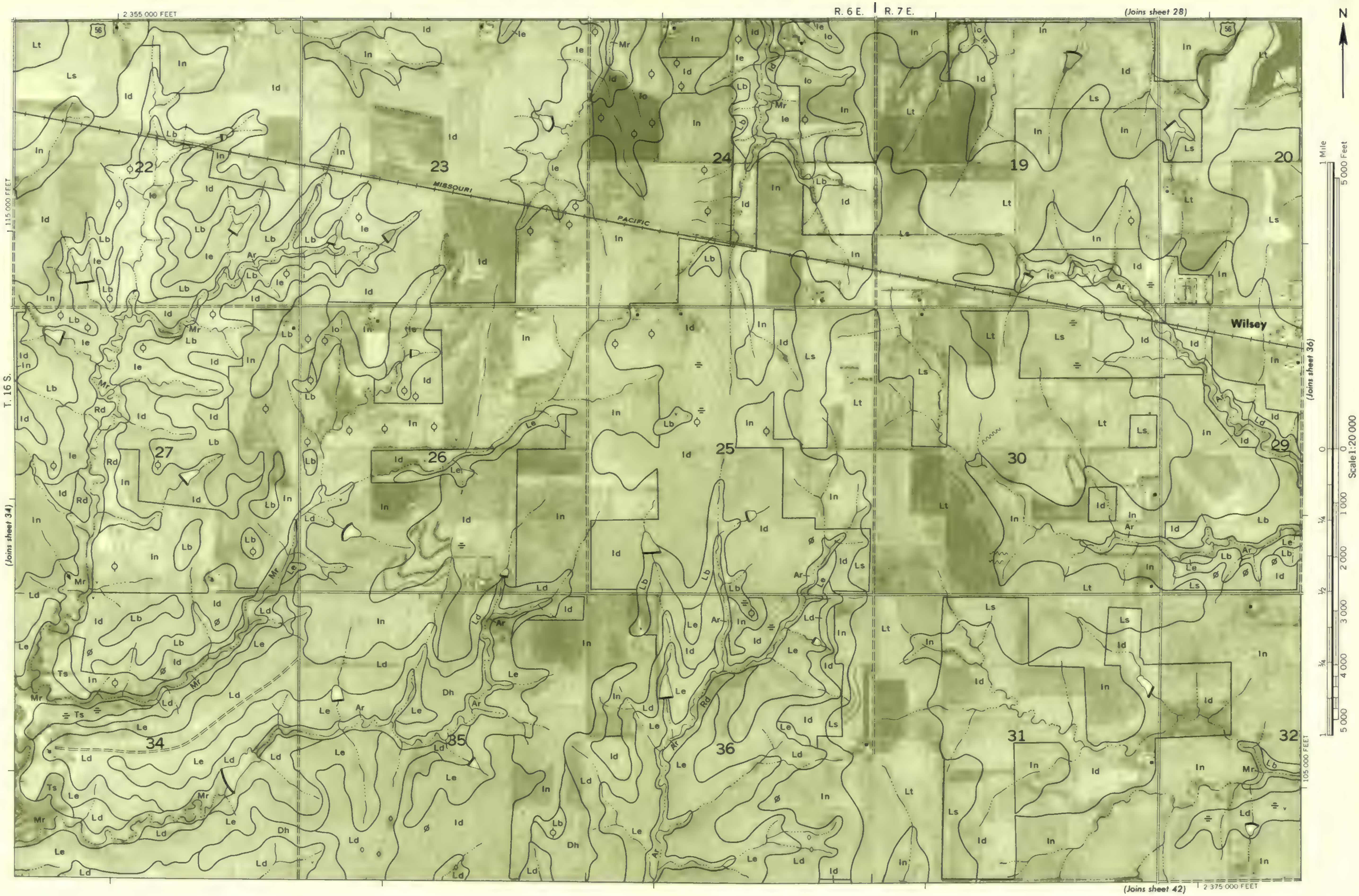
Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, north zone.

This map is one of a set compiled in 1971 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.

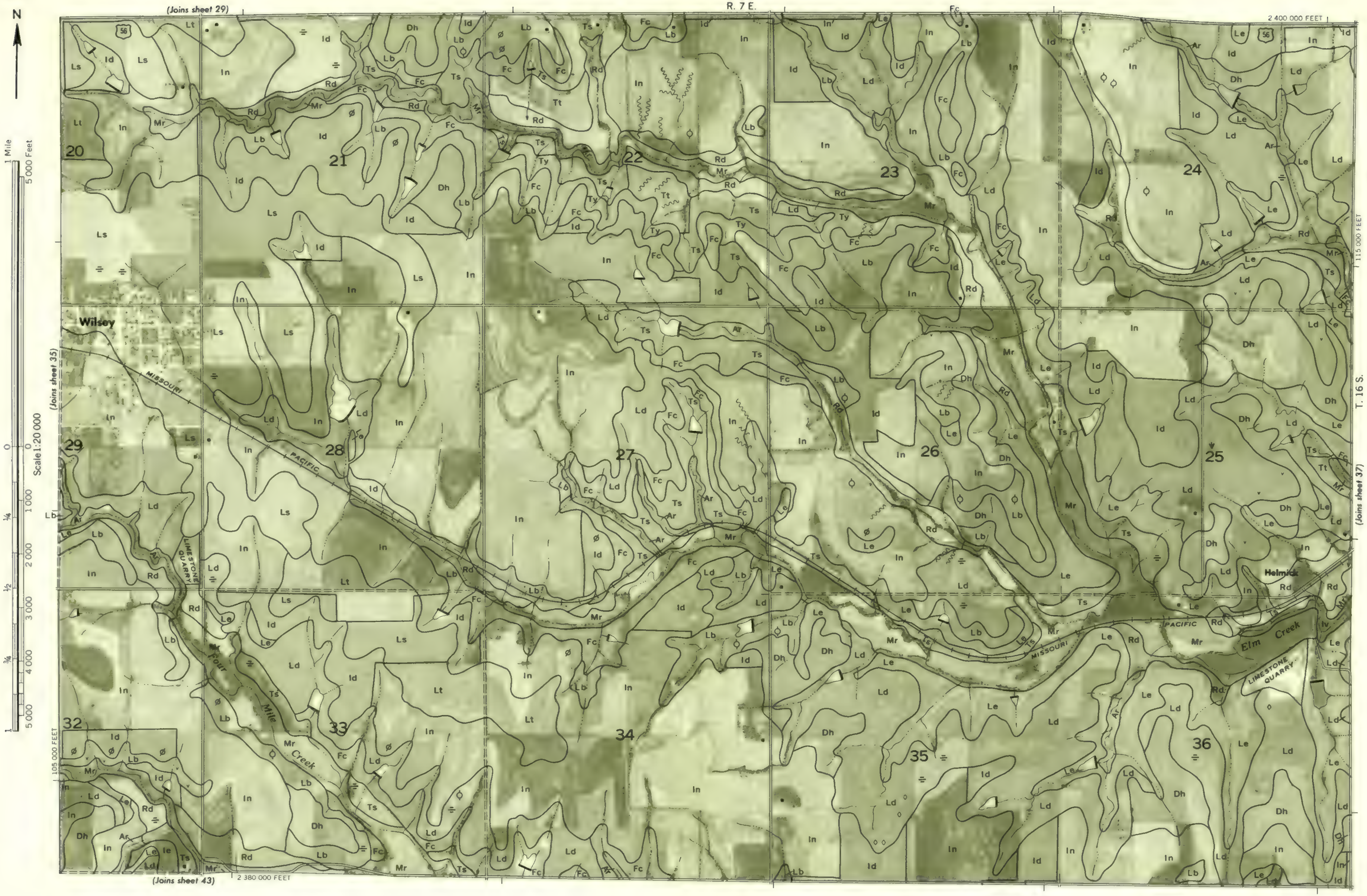
MORRIS COUNTY, KANSAS — SHEET NUMBER 35

35



MORRIS COUNTY, KANSAS NO. 35

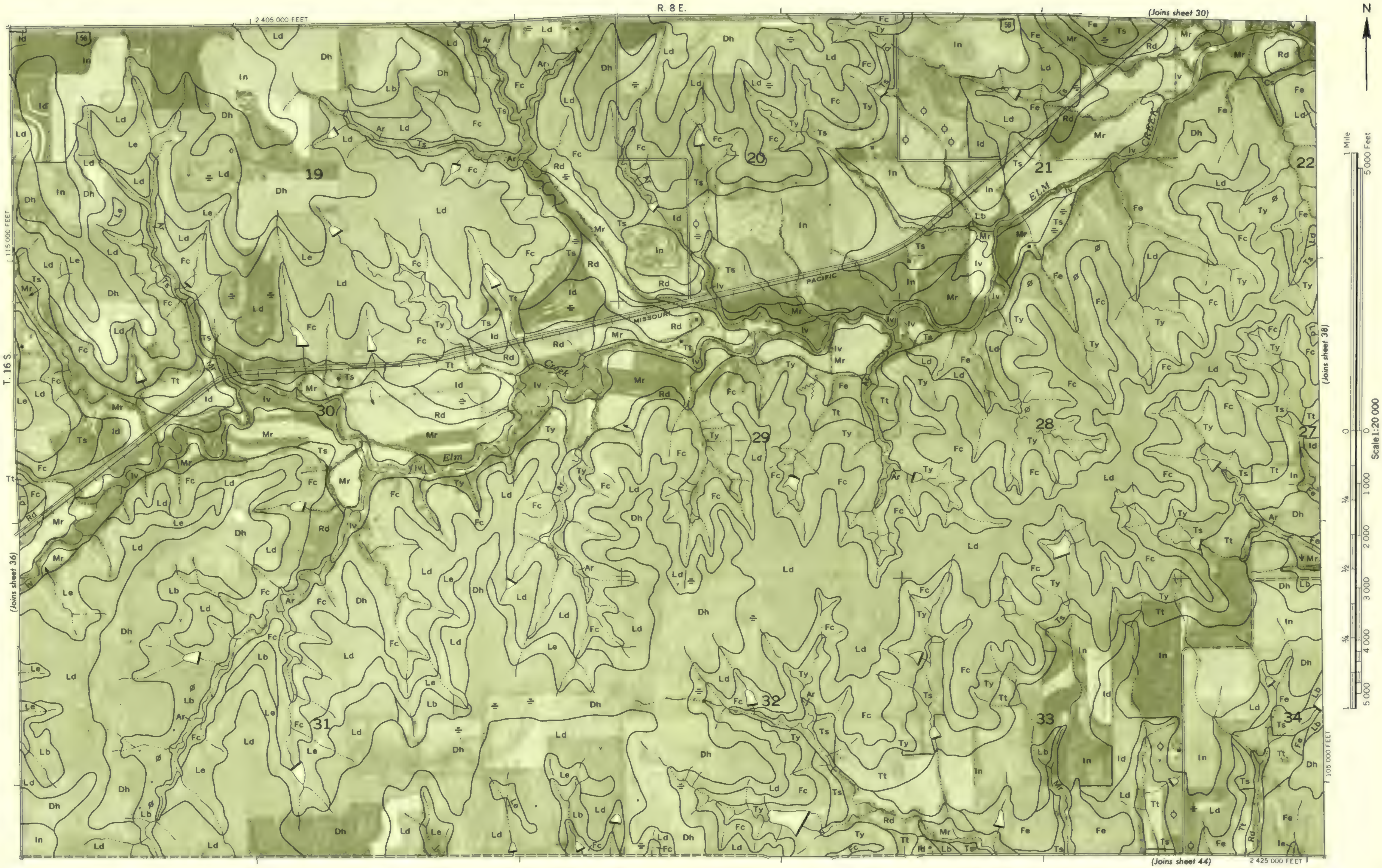
This map is one of a set compiled in 1971 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, north zone.
Land division corners are approximately positioned on this map.



Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, north zone

This map is one of a set compiled in 1971 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station



MORRIS COUNTY, KANSAS NO 37

This map is one of a set compiled in 1971 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, north zone

Land division corners are approximately positioned on this map.

MORRIS COUNTY, KANSAS — SHEET NUMBER 38

Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000 foot grid ticks are approximate and based on the Kansas coordinate system, north zone

This map is one of a set compiled in 1971 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station

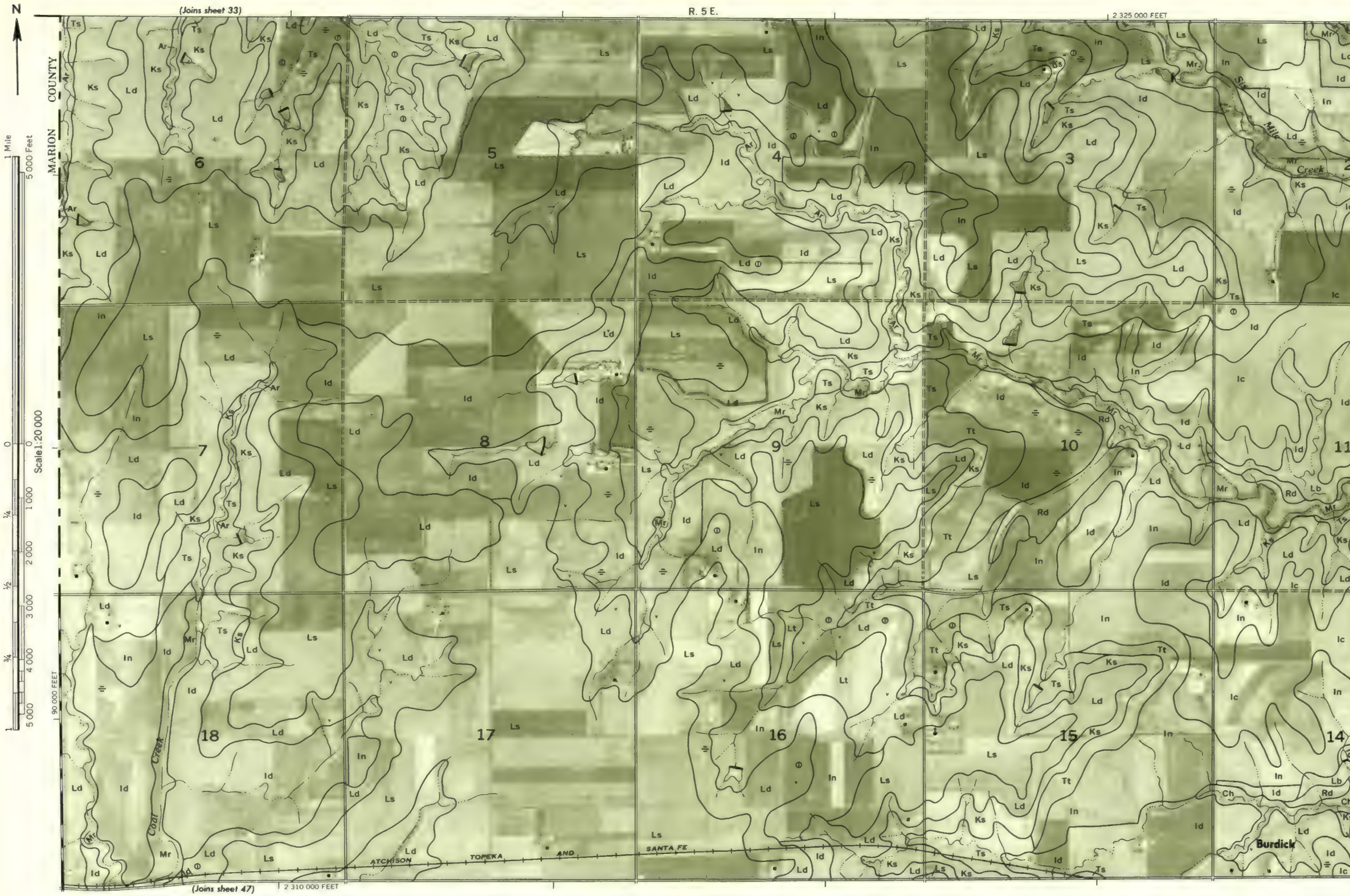
39

MORRIS COUNTY, KANSAS NO. 39

This map is one of a set compiled in 1971 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, north zone

Land division corners are approximately positioned on this map.



Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, north zone.

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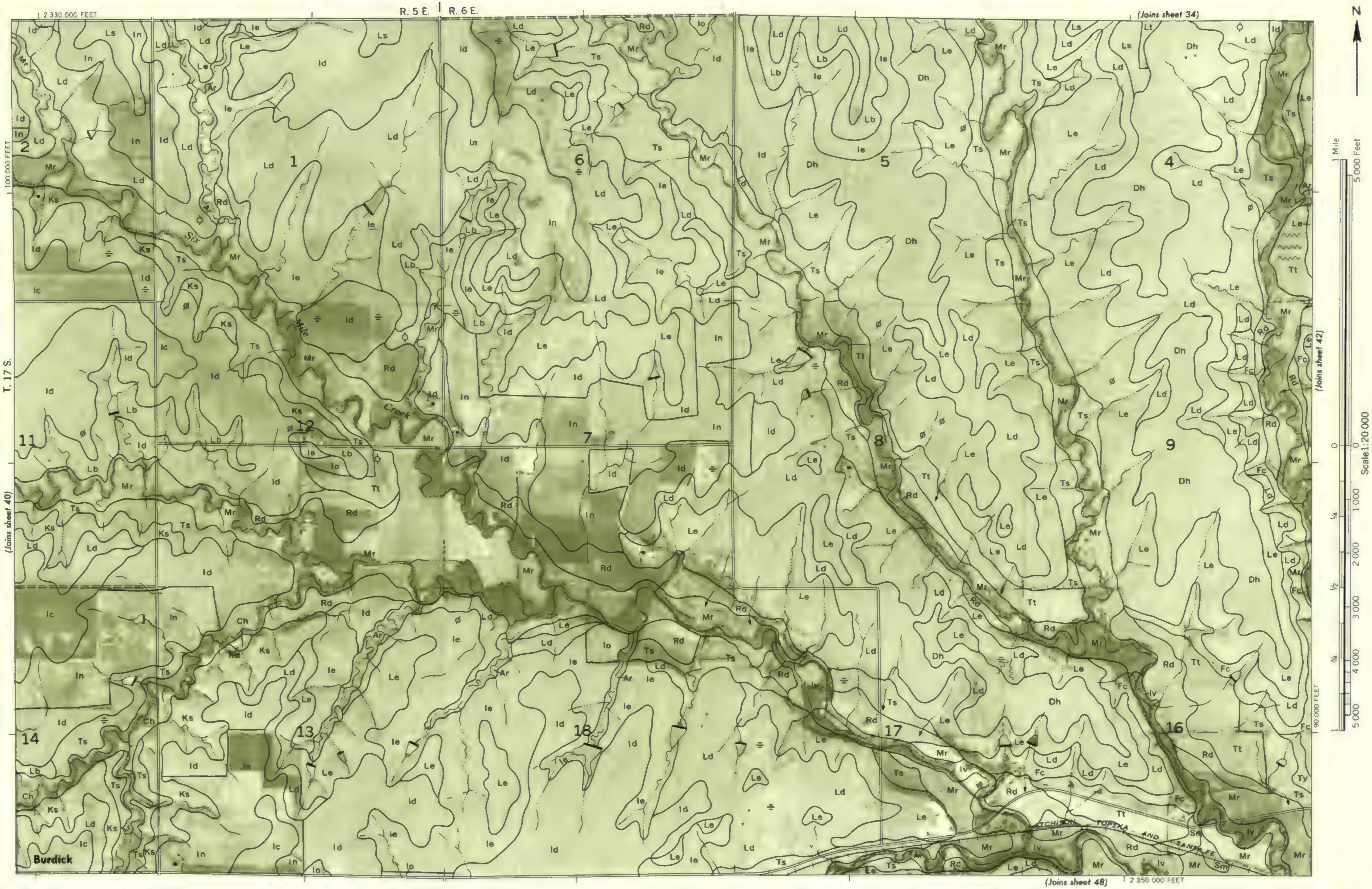
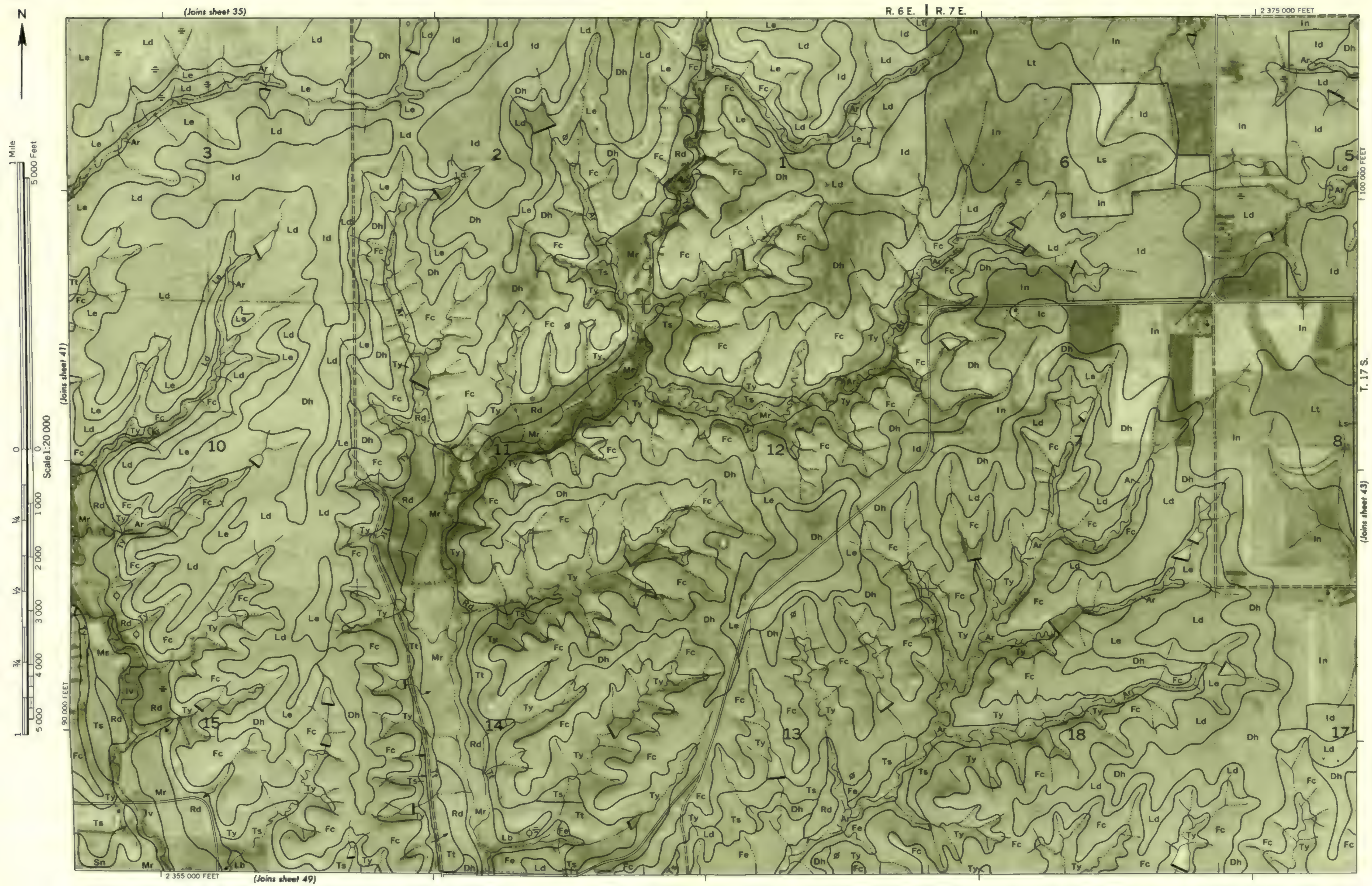


MORRIS COUNTY, KANSAS NO. 41

This map is one of a set compiled in 1971 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station. Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, north zone.

Land division corners are approximately positioned on this map.

MORRIS COUNTY, KANSAS — SHEET NUMBER 42



Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, north zone.

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MORRIS COUNTY, KANSAS NO. 43

This map is one of a set compiled in 1971 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, north zone

Land division corners are approximately positioned on this map.

MORRIS COUNTY, KANSAS — SHEET NUMBER 44

Land division corners are approximately positioned on this map.

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, north zone.

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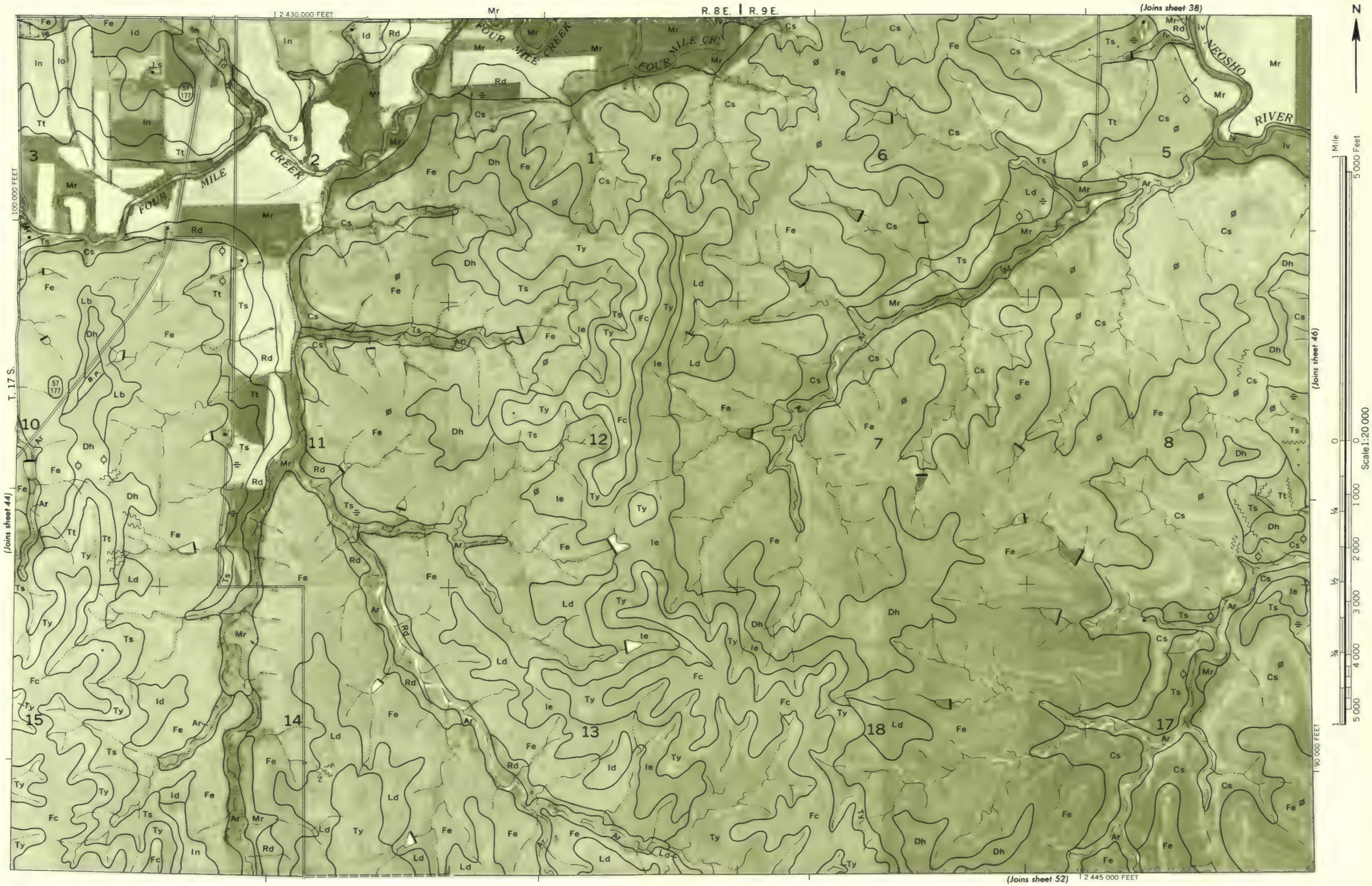
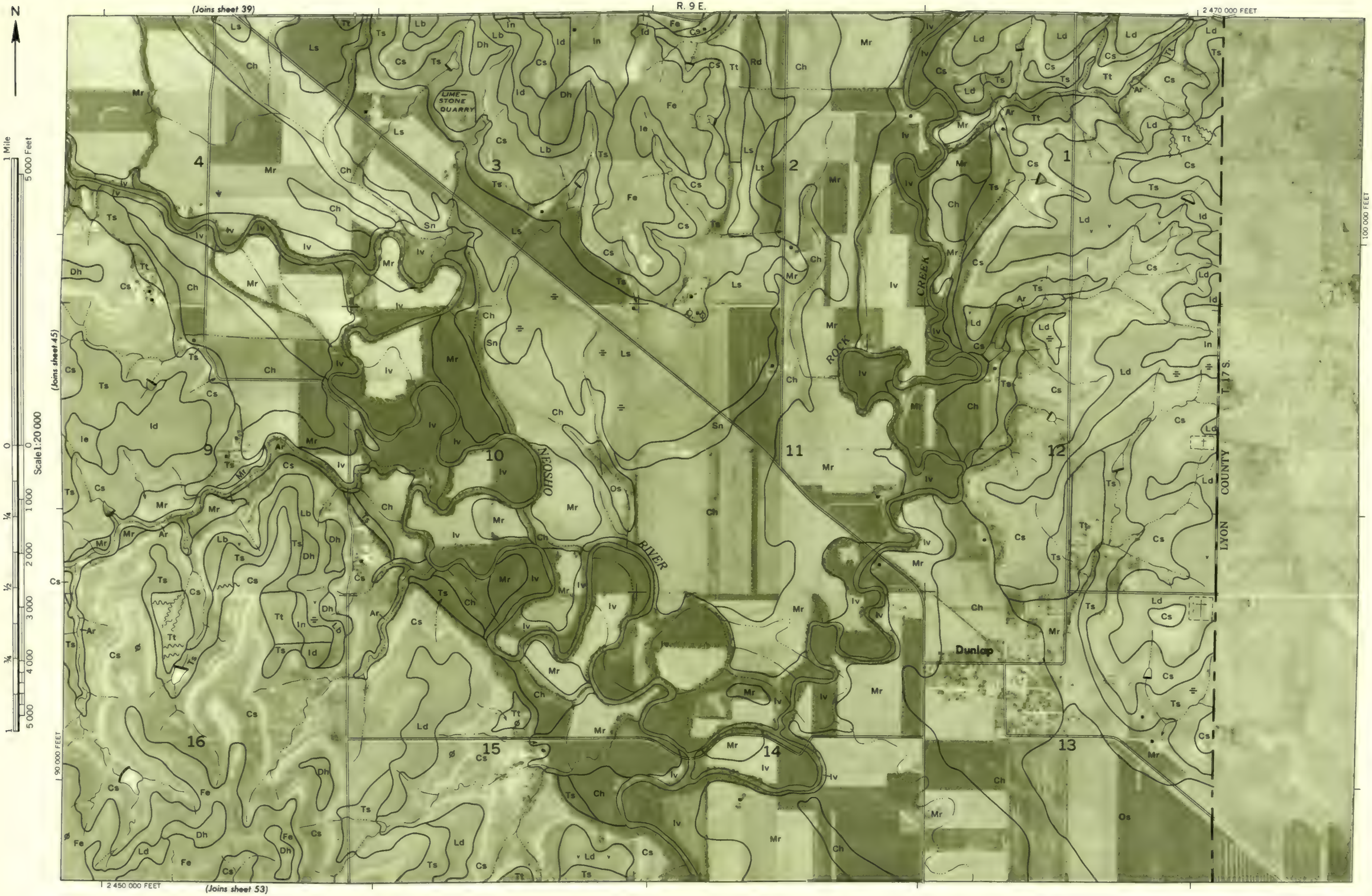


MORRIS COUNTY, KANSAS NO. 45

This map is one of a set compiled in 1971 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, north zone.
Land division corners are approximately positioned on this map.

MORRIS COUNTY, KANSAS — SHEET NUMBER 46



Land division corners are approximately positioned on this map.

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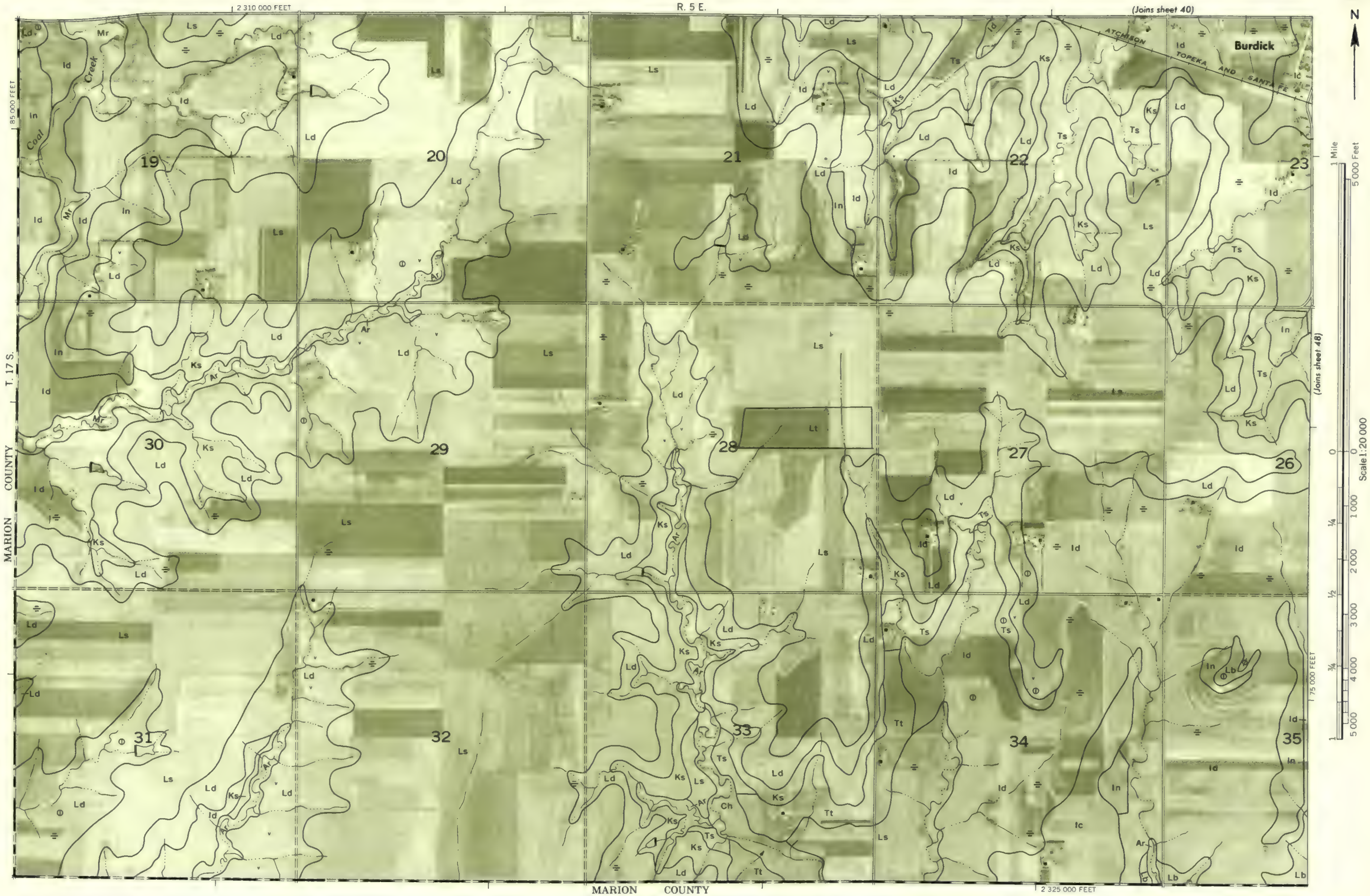
MORRIS COUNTY, KANSAS NO. 46



MORRIS COUNTY, KANSAS NO. 47

This map is one of a set compiled in 1971 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, north zone.
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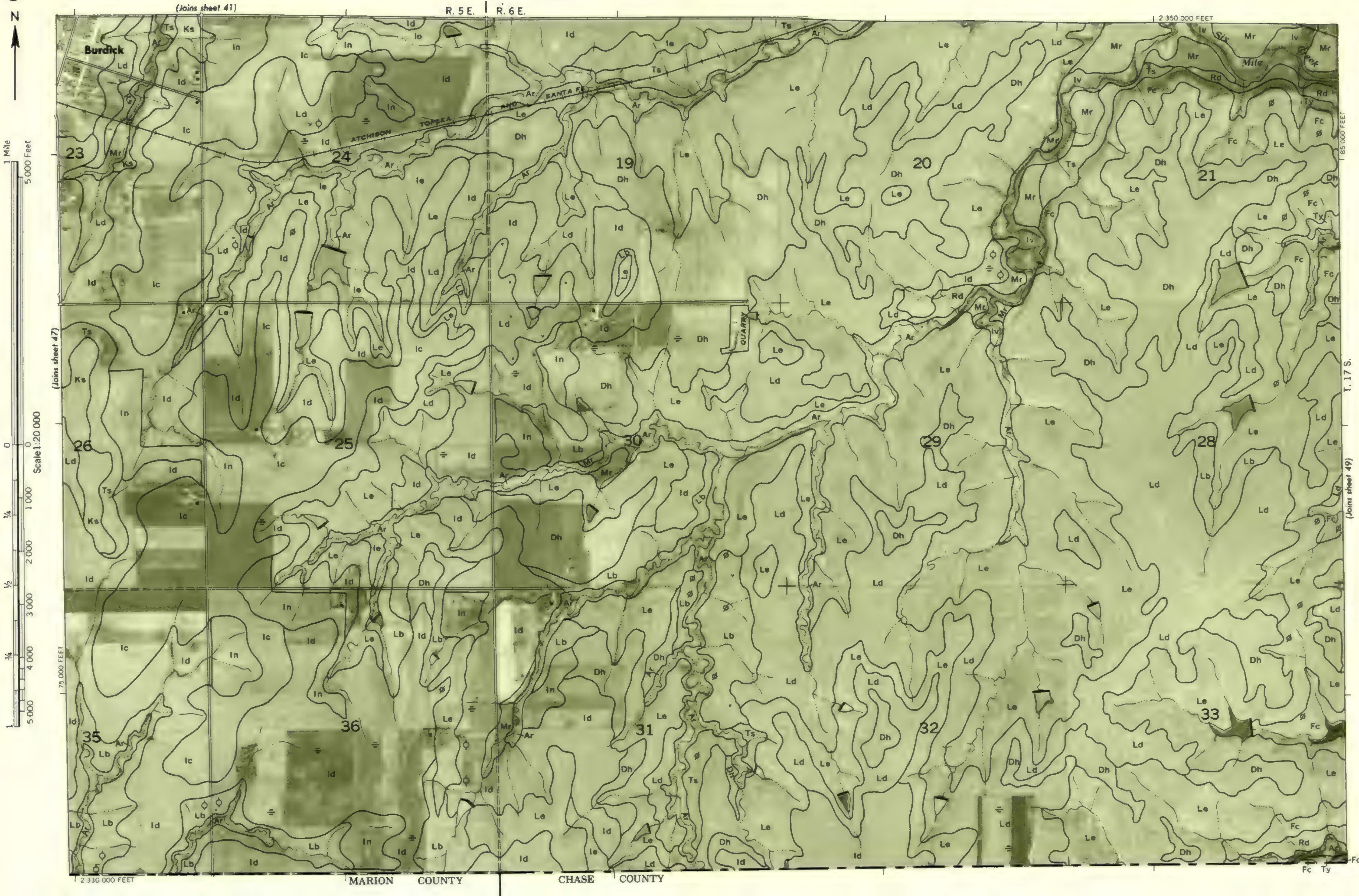
MORRIS COUNTY, KANSAS — SHEET NUMBER 48



Land division corners are approximately positioned on this map.

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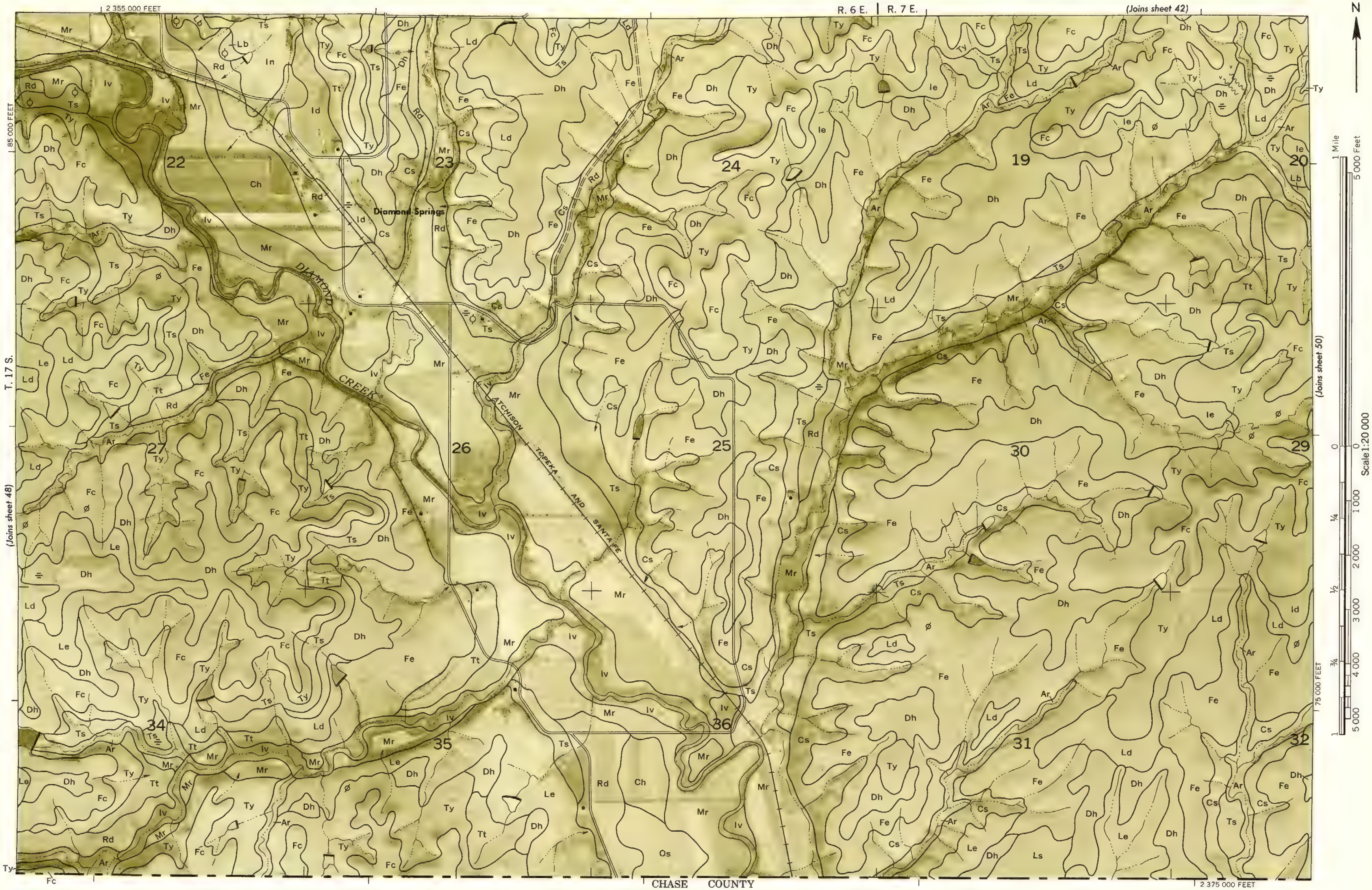
2 355 000 FEET
R. 6 E.
R. 7 E.
(Joins sheet 42)
N
85 000 FEET
T. 17 S.
(Joins sheet 48)
(Joins sheet 50)
Diamond Springs
DIAMOND
CREEK
ATCHISON
TOPEKA
AND
SANTA FE
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32
CHASE COUNTY
2 375 000 FEET
75 000 FEET
1 Mile
5 000 Feet
Scale 1:20 000
0
¼
½
¾
1
1 000
2 000
3 000
4 000
5 000


N
(Joins sheet 43)
R. 7 E.
2 400 000 FEET
85 000 FEET
T. 17 S.
(Joins sheet 51)
(Joins sheet 49)
1 Mile
5 000 Feet
Scale 1:20 000
75 000 FEET
2 380 000 FEET
CHASE COUNTY
20
21
22
23
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35
36

MORRIS COUNTY, KANSAS NO. 51

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MORRIS COUNTY, KANSAS NO. 53

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Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, north zone.
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